POWER

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What Price Bidding?

A manufacturing firm of importance and high standing in the power field was requested by a big purchaser to prepare designs for a new installation. Then plans were changed and another set of designs was made and a sample apparatus was built for demonstration.

All of which goes to show that the bidding company was sincere and assumed it was working on an open job with opportunity for meritorious design and performance.

But it turned out that this particular manufacturer was doomed to disappointment before he started. And the domination of the designing department of the purchasing company by another department of the same organization was at the back of it.

This fact was known inside the ranks of the purchasing company. Yet its outside effect was overlooked to the extent where at least one manufacturing company was permitted to spend thousands of dollars merely to provide hopeless competition.

Furthermore, the buyer was much benefited by this and by the numerous ideas of the unsuccessful competitor which appeared in the apparatus actually installed. Purchasing ethics in matters of this sort, even among some of our largest organizations, are still conspicuous by their absence.

EDITORIALS

Engineers and This Machine World

We live in a world of steam, electricity and machines. The whole fabric of modern civilization rests on mechanical processes devised and built by engineers.

Who directs this great mechanism, which is nothing but an aggregate of smaller mechanisms? Engineers in detail. At the top non-engineers largely.

Is this perhaps a part explanation of the perpetual blundering so evident when one views broadly the operation of industry and business? Is it possible that the engineering mind—direct, honest, intelligent—applied on the higher levels of business and social coordination would bring some order out of chaos?

On this point opinions differ. Some say "Yes." For example, Dr. Alfred D. Flynn of the Engineering Foundation recently declared, "Who other than the keen-visioned, clear-thinking, broad-minded men among scientists and the appliers of science through engineering and industry can help their fellow-men to understand the scientific, the engineering, the machine age? Who better than they can supply the new element in leadership for which confused humanity is groping?"

The skeptic may reply that qualifications other than engineering skill are required in the dominant places—that salesmanship and financial sagacity are essential and that these are no definite part of the engineer's equipment.

Both are right. Leaders must have these qualities. Likewise more engineers must be leaders of industry if a scientific civilization is to survive. The answer will be gradually furnished by engineers themselves. From the engineering ranks men have arisen here and there with all the necessary non-engineering qualifications. More will come as the public necessity and the individual opportunity are better understood.

The Small Smoke Offender

One of the problems that besets smoke departments in some of our cities is created by the apartment house owner who has been induced to install a small stoker under his heating boiler as an economy measure. Now a stoker, when properly installed, is an effective step toward both the economical burning of coal and the abatement of smoke; but one must be sure that the installation is properly made.

Too often these small stokers have been improperly sold and sometimes misapplied. Either the owner is unwilling to incur the expense of providing the proper setting or the salesman is not backed by the requisite engineering service. Many such installations are made with inadequate setting heights or too small furnace volumes and the result is smoke accompanied by poorer economy than that otherwise attainable.

While there is still some difference of opinion as to the most desirable setting heights with different types of boilers, there are certain minimums dictated by sound engineering judgment. Fortunate are the smoke inspection departments that are empowered by statute to pass upon the plans for such installations in advance. By so doing they are able to eliminate one of their most troublesome problems and at the same time render a service to boiler owners and to the community.

An Open Door To Patent Reform

The United States patent law of today differs from the original draft of 1836 in minor details only, in spite of the intervening industrialization of the country on a revolutionary scale. Well designed for the oxcart era, it is holding up traffic in this age of machines. The demand for a new model is insistent. This need has been evident for years. Complaints have been many, but the net result has been mere tinkering with the patent law—not the fundamental overhauling new conditions demand.

Those who have suffered by and complained of governmental ineptitude in this field have now a fair opportunity to promote action. As reported last week in *Power*, the House Committee on Patents, through the initiative of its chairman, Representative William I. Sirovich, is now holding public hearings in Washington on the patent law. Until March 1 any industrialist or other citizen with practical suggestions may lay them before the committee, which hopes to effect a fundamental revision based on the true needs of American industry.

These hearings are not the usual discussions of some bill already drafted by a Congressional committee, but a real opportunity to lay the groundwork for something worth while.

The formulation of a sound patent code is a matter only incidentally for patent lawyers and other legal specialists. Engineers and industrial leaders are more directly concerned. It is to be hoped that those who understand the problem best will participate actively, either by going to Washington in person or through correspondence with the committee.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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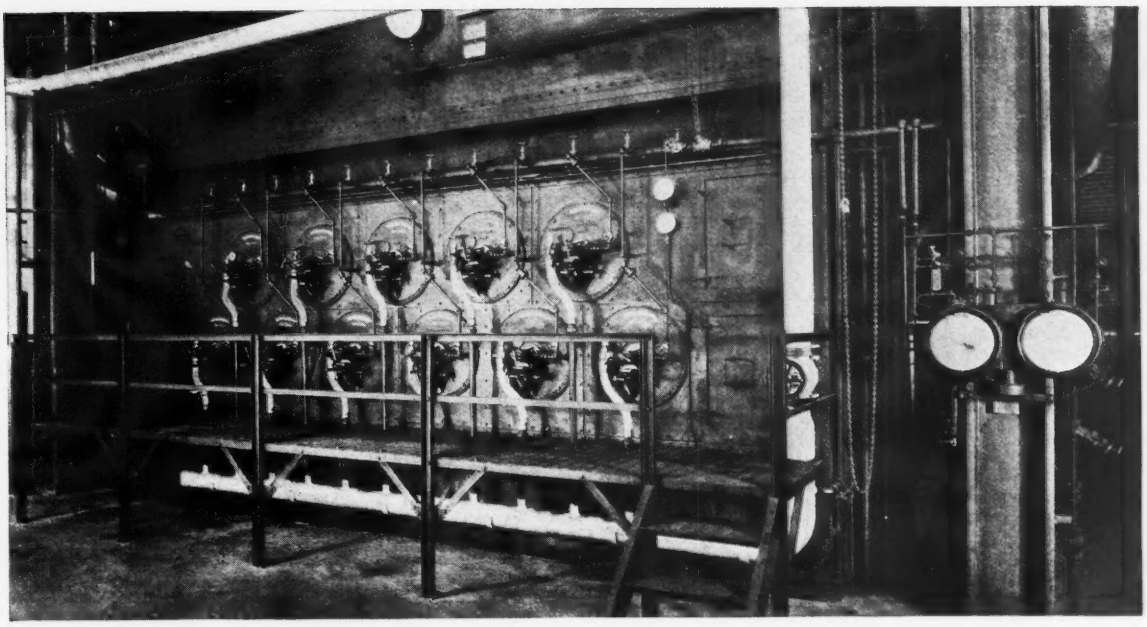

Fig. 1—Combination natural gas and oil burner installation under 10,506-sq.ft. boiler at K street station

Burning Natural Gas On Off-Peak Basis

Stoker equipment in four different plants placed in storage or suitably protected to permit use of natural gas. Oil is used as standby fuel and in three of the plants a coal-fired boiler is retained to replace gas should the supply be cut off for long

IN 1930, through a group of gas utilities, the United Light & Power Company[1] became interested in the transmission and distribution of natural gas from the Texas and Kansas fields. Starting at Skellytown, Texas, the pipe line extends northeast, supplying, among other cities in its course, Lincoln, Neb., and Fort Dodge and Mason City, Iowa. Although the general plan is to distribute the gas through the properties devoted to this field, it was realized that some time would be required to build up the load to the capacity of the line, and even then variations in the demand would create a surplus that would have to be used if full advantage were to be taken of line capacity to help pay the overhead and investment charges.

To help load up the main transmission line and thereby improve the load factor, decision was made to burn natural gas on an off-peak basis in certain electric generating plants of subsidiary companies. In order that the gas might compete favorably with coal in the respective territories, this off-peak gas was offered at a rate slightly under the cost of coal. Advantages additional to that of price anticipated from the use of the natural gas were greater capacities from the boilers, less labor and lower maintenance on the fuel-burning equipment and the furnace

At Lincoln, Neb., the gas was brought into the old Second Street generating plant, and the recently completed K Street Station of the Iowa & Nebraska Light and Power Company. The former plant contained six 6,000-sq. ft. water-tube boilers equipped with chain grates. Operating at 225 lb. steam pressure, the plant is being used to carry the swings in the load, while K Street station carries the base load. In four of these boilers the stokers were removed and each furnace equipped with eight natural-draft gas burners, and, as a reserve, in case that the gas should be turned off, back shot oil burners. Refractory-lined furnaces limit capacities to approximately 200 per cent rating.

Two of the boilers equipped with forced-draft chain grates and economizers had been set higher, so the grates were allowed to remain in place. I-beams laid on the grate were covered by steel plate and 6 in. of firebrick. With the fan already available, air for combustion is forced through the grates to cool the furnace floor and is carried on to the burners preheated to a temperature of 150 deg. F. Eight burners per boiler are used, and the gas pressure at the burner ranges from 3 to 10 lb., depending upon the rating desired.

[1] Chicago, Ill.

Recently completed and designed for high efficiency, K Street station[2] contains two 10,500-sq.ft. cross-drum boilers, each with a maximum steaming capacity of 140,000 lb. per hour. Steam is generated at a pressure of 600 lb. and a total temperature of 740 deg. The equipment includes 11-retort, 41-tuyère underfeed stokers, water walls, combination convection and radiant superheaters, economizers and air preheaters. As indicated in Fig. 2, the boilers are set high, the bottom of the lower head being 16 ft. 6 in. above the floor, to give a furnace volume of 5,950 cu.ft.

Burning Kansas coal from the Cherokee seam on underfeed stokers presented certain difficulties. Higher capacities, less operating trouble and lower furnace maintenance were anticipated from the use of natural gas. One of the boilers was changed for gas firing by removing the upper part of the stoker, made up of the retorts and tuyères. These parts were placed in storage to be immediately available whenever coal became the more economical fuel to burn. Over the existing stoker-supporting steel a furnace floor was built, consisting from the bottom up of $\frac{1}{4}$-in. steel plate as a sealing floor, $\frac{1}{2}$-in. crushed firebrick, $2\frac{1}{2}$-in. of firebrick, another $\frac{1}{2}$-in. layer of crushed firebrick and $4\frac{1}{2}$ in. of firebrick. The clinker rolls were covered by cinders, with a sealing layer of firebrick at the top. Arrangements were made to cool the furnace floor with the air for combustion, the supply being drawn from the air preheater at a temperature ranging from 300 to 350 deg., and forced under the furnace floor to the windbox of the burners by the fan originally serving the stoker. In combustion air temperature a 300-deg. rise increases the over-all efficiency, under the conditions existing in this plant, by 5.6 per cent over taking air at room temperature.

To develop maximum capacity the boiler has been equipped with eleven combination gas and oil burners, the oil, as before, being the reserve fuel. At present the gas comes to the plant at a pressure of 50 lb., but when the line is more fully loaded this pressure may drop to a minimum of 35 lb. Full boiler capacity of 140,000 lb. of steam per hour is guaranteed on a maximum gas pressure at the burner not to exceed 15 lb. per square inch and a forced-draft pressure of $\frac{1}{2}$ in. of water.

[2]For description see *Power*, Dec. 22, 1931.

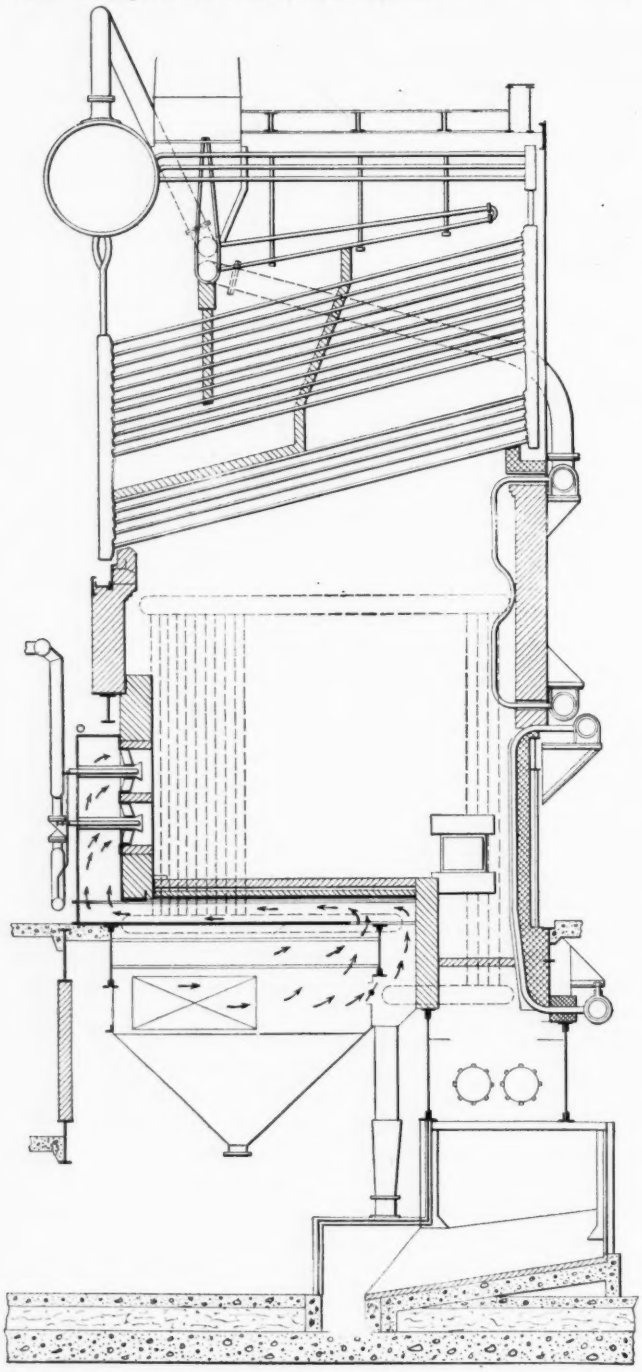

Fig. 2—Section through boiler, showing furnace floor construction and method of introducing combustion air

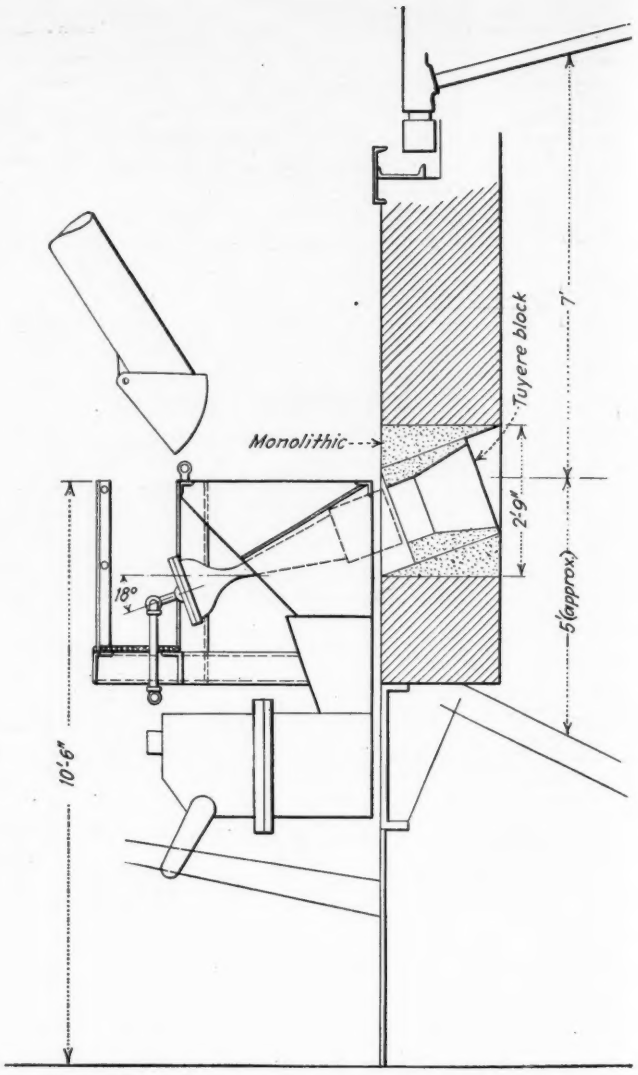

Fig. 3—Natural-gas burner for maintaining hot bank installed through stoker hopper

As the services of the second boiler in the plant are required at present only over peak periods at reduced raing, the stoker has been retained. To make it possible to get this boiler on the line promptly, one natural-gas burner has been installed through the stoker hopper, as shown in Fig. 3, with provision to put in three more burners if desired. The burner is used to keep the boiler in hot bank while the stoker is operated at a rate just sufficient to keep the grates covered. Bringing the boiler into service, the gas flame helps to kindle the coal-fire, and if the load is heavy the gas burner may be continued.

Other installations were made in the electric utility plants at Mason City and Fort Dodge. In both stations two boilers were equipped with combination gas and oil burners and one coal-fired boiler retained as stand-by in the event that gas might not be available for long periods of operation. Oil is the normal stand-by fuel for intermittent periods of short duration.

As both plants were equipped with underfeed stokers, the installations are quite similar to that at K Street station. At Mason City boilers with 5,380 sq.ft. of surface and water-cooled furnace walls are each equipped with four burners to generate 75,000 lb. of steam per hour. Boilers of 4,940 sq.ft. at Fort Dodge, with refractory type furnaces, are provided with three burners each to provide for a steaming capacity of 50,000 lb. per hour.

Data available from K Street station, Figs. 4 and 5, serve to compare performances with coal and natural gas. The solid fuel used was Kansas coal from the Cherokee seam. Its quality is indicated by the ultimate analyses in Table I.

TABLE I — ULTIMATE ANALYSES OF CHEROKEE COAL

	Per Cent by Weight
Carbon	60.65
Hydrogen	3.97
Sulphur	3.27
Oxygen	6.63
Nitrogen	1.33
Moisture	9.90
Ash	14.25
Total	100.00

The heat content approximates 11,000 B.t.u. per pound. The theoretical air for combustion is 7.74 lb. per pound of coal, and the maximum CO_2 obtainable 18.5 per cent. On the basis of 13 per cent CO_2, a fair operating figure, dry products of combustion aggregate 11.96 lb. per pound of coal.

An analysis of the natural gas in use appears in Table II.

TABLE II — NATURAL GAS ANALYZED

	Per Cent by Volume
CO_2	0.14
Oxygen	0.00
Methane	74.10
Ethane	17.87
Residue	7.89
Total	100.00

At 60 deg. F. and 30 in. of mercury the heat content of the gas per cubic foot is 1,062 B.t.u. The maximum CO_2 obtainable is 12.05 per cent. The dry products of

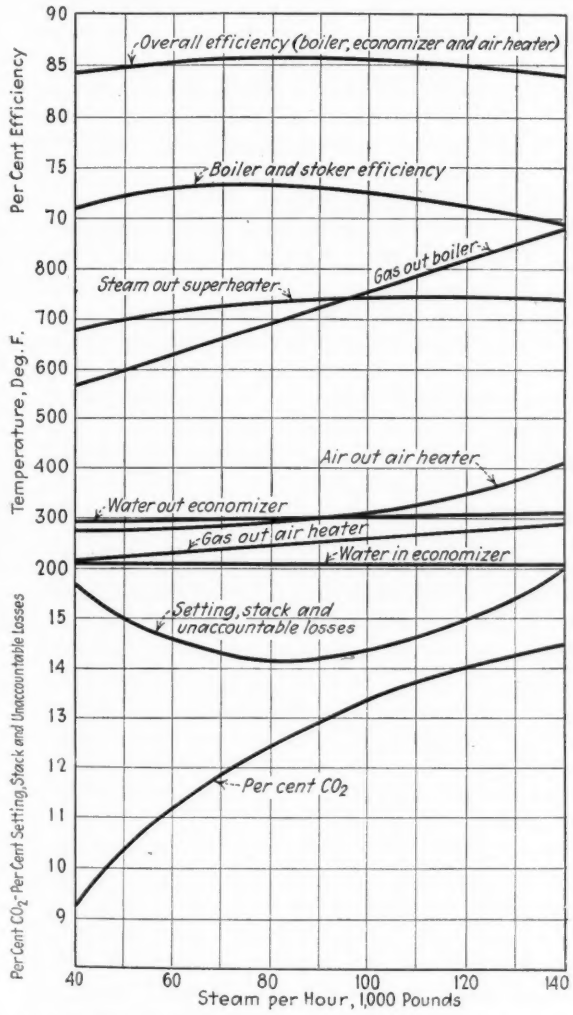
Per Cent Efficiency
Overall efficiency (boiler, economizer and air heater)
Boiler and stoker efficiency
Temperature, Deg. F.
Steam out superheater
Gas out boiler
Air out air heater
Water out economizer
Gas out air heater
Water in economizer
Per Cent CO_2-Per Cent Setting, Stack and Unaccountable Losses
Setting, stack and unaccountable losses
Per cent CO_2
Steam per Hour, 1,000 Pounds

Fig. 4—Boiler performance over ten-day period with coal as fuel

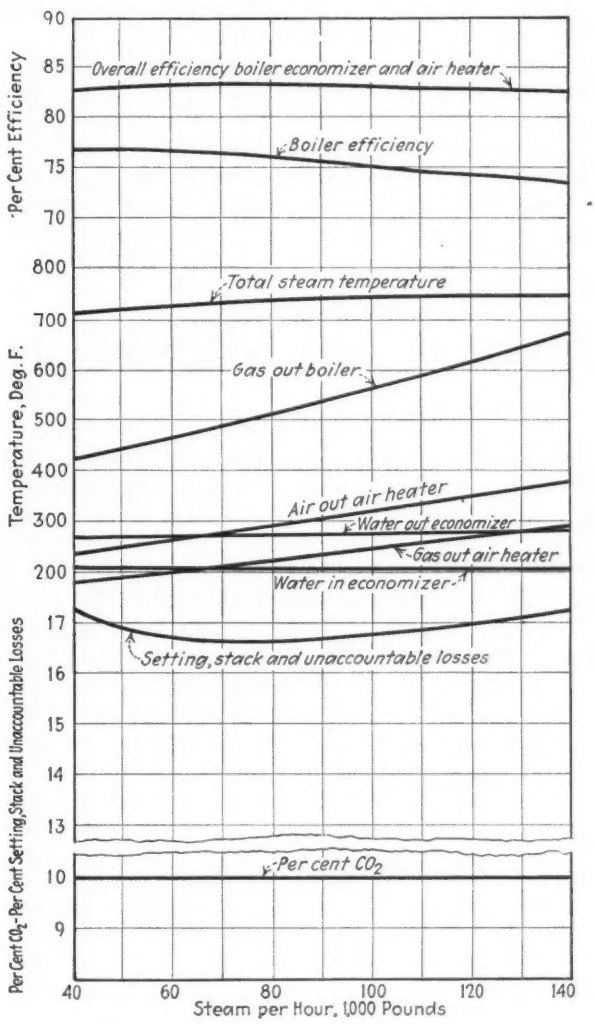
Per Cent Efficiency
Overall efficiency boiler economizer and air heater
Boiler efficiency
Temperature, Deg. F.
Total steam temperature
Gas out boiler
Air out air heater
Water out economizer
Gas out air heater
Water in economizer
Per Cent CO_2-Per Cent Setting, Stack and Unaccountable Losses
Setting, stack and unaccountable losses
Per cent CO_2
Steam per Hour, 1,000 Pounds

Fig. 5—Comparative performance with natural gas

combustion figure 9.087 cu.ft. per cubic foot of gas; adding 2.018 cu.ft. of water vapor gives a total of 11.106 cu.ft. For an operating condition of 10.5 per cent CO_2 the total products of combustion increase to 12.419 cu.ft. per cubic foot of gas.

Being on the weight and volume basis, respectively, the foregoing figures are not comparable, but it may be stated that for equal heat release in the furnace, and assuming typical operating conditions for each fuel, the products of combustion from the gas weigh 18 to 20 per cent less than do those from the coal. Operation has shown that good results from the gas can be obtained with 10 per cent or less excess air, while with the coal the minimum excess air requirement ranges from 30 to 40 per cent.

Other variations in operating data appear in the charts, which were made up from ten-day averages under typical load conditions. At a steam load of 80,000 lb. per hour the exit gas temperature from the boiler is 180 deg. less with natural gas than with coal, owing to less weight in the products of combustion and to the better heat absorption in furnace and boiler surface, accounted for by cleaner surfaces and lower velocities. Out of the air heater the difference has been reduced to 20 deg. Throughout the entire load range the superheat temperature with gas fuel is slightly higher, owing to the higher absorption of the radiant superheater overcoming the lower absorption by the convection superheater. In the former the temperature is about 70 deg. higher when using gas fuel, and the temperature of the steam from the convection superheater about 50 deg. less than with coal, as a result of lower gas temperatures and less weight of gas over the superheater surfaces.

Between the two methods of firing there is a difference in over-all efficiency ranging from 1½ to 2½ per cent in favor of coal fuel. This difference is mainly due to the high hydrogen loss common to gas firing. The loss is approximately 5½ per cent greater than with coal, but with the latter fuel ashpit and certain unavoidable losses are offsets that materially reduce this disadvantage.

Lubrication and Machine Life

By ALLEN F. BREWER

WHILE the end may not justify the means always, in the accomplishment of certain ideals experience has proved that first cost of the wherewithal should not be guarded too carefully. This will hold true in connection with lubrication, for one has but to weigh the cost of lubricants against the potential cost of a burned-out bearing, with all its attendant expense, to realize the fallacy of quibbling over a few cents per gallon of oil or per pound of grease. Too often is this entirely overlooked, to the serious impairment of machine efficiency and, frequently, the marked reduction in the useful life of mechanical equipment.

The matter of useful life commensurate with production ability should always be considered as virtually dependent upon lubrication, for after all there can be no more effective method of eliminating the potential wear of parts moving in contact with one another than by the maintenance of a suitable friction-reducing film of lubricant.

In the practice of valuation engineering there is an estimated useful life applied to every type of machine. This plays an important part in calculation of the tangible assets of any concern. The valuation engineer has tacitly assumed that effective lubrication will be practiced, although this is not stated in so many words. Instead, he fixes his estimated useful life period on the assumption of judicious operation and intelligent maintenance. In other words, he compliments the plant management upon its common sense in realizing that the machinery must be properly maintained.

Too few of them realize the full sense of this responsibility, being led into false ideas as to economy by penny-saving purchasing methods, with utter disregard of the dollar losses which may accrue when machinery must be scrapped at too early a date. This may be condoned on the basis of obsolescence, but unless a machine is entirely unable to cope with production demands, or unless its power-consuming characteristics are abnormal, it cannot fairly be classed as so absolete as to justify replacement. In fact, frequently by altering the means of lubrication all this can be corrected.

In consequence, obsolescence should be clearly understood, and not considered too literally. But the efforts of the progressive machinery builder to assist in the reduction of production costs should not be ignored, and where warranted a machine should be scrapped immediately. This is especially true if improvements in installation or operation will enable a lower production cost. As a rule, however, when machinery is scrapped too early in its life it is due primarily to cheap and faulty lubrication.

A thought frequently lost sight of by many purchasers of lubricants is the extent to which the products they are buying are suitable to the operating conditions, and the available means of application. Purchasing agents especially are prone to disregard this factor in the sole interest of reducing the cost of supplies; yet such an attitude may easily lead to marked increase in cost of repair, labor and new parts, if the lubricants are incapable of meeting the operating conditions.

In other words, unsuitability of a lubricant may affect the rate of production, the maintenance costs, wear and tear, and the power consumption.

It is obivous that with such an alarming array of expensive possibilities no individual or department should be vested with the responsibility of final selection of the necessary lubricants unless he is intimately familiar with the service required. This, of course, entails a working knowledge of the operating conditions, including speed, pressure and temperature.

In addition to these factors, however, understanding of the prevalent possibilities of oil or grease contamination, as well as knowledge of the limitations of the means of lubrication available, will be of value in a determination of the extent to which one should go to higher-priced lubricants, and the economy to be expected.

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ALL DIVISIONS of the refrigerating engineering field will be covered in the new "Refrigerating Data Book and Catalog," to be published in April by the American Society of Refrigerating Engineers. Basic data will be given on machinery and equipment, insulation and containers, and application of systems. Thirty selected authors, each an authority in his own field, are now preparing the material. An appendix will contain all A.S.R.E. codes previously published and drafts of two proposed codes. Reference data, bibliography, glossary and conversion tables will be included.

Steam Vs. Electric Drive For Power-Station Auxiliaries

A review of the characteristics and economics of steam and electric drives for steam power station auxiliaries, as presented at the recent winter convention of the American Institute of Electrical Engineers, held in New York City. This subject is divided into two parts: Steam-driven auxiliaries and electrically driven auxiliaries for steam stations, with an introduction dealing with the general subject of auxiliary drives

A NUMBER of large steam stations have been built recently in which practically all of the auxiliaries are electrically driven; in others, steam-driven auxiliaries have been used extensively. This variation in practice caused the A.I.E.E. Power Generation Committee to sponsor a review of the characteristics and merits of steam and electric auxiliary drives in the light of present conditions and past operating experience.

Reliability of plant operation was given the place of major importance in the various considerations that enter into the selection of auxiliary drives. F. H. Hollister, electrical engineer, Sargent & Lundy, Inc., said that the public has become accustomed to expect continuous service and that the large investment charges of the power station companies and their industrial customers demand it. One of the most important factors in continuity of power service is reliability of the auxiliary equipment required at the power stations.

In the past, station designers have used adjustable-speed drives for fans, pulverizer mills, boiler-feed pumps and circulating pumps quite extensively. Recently there have been developments in the manufacture of auxiliary equipment and station design that have made adjustable speeds less necessary. The one exception to this trend is boiler-feed pumps for high-pressure boilers. The paper on steam-driven auxiliaries brought out very clearly the advantages of the steam turbine as a simple and efficient means for obtaining adjustable-speed drive for auxiliaries.

It was shown in the papers that the type of drive best suited for the essential auxiliaries, such as fans, boiler-feed pumps, and circulating pumps, is closely related to and dependent upon the general design of the station. The general station design, in turn, is influenced by the relation of the station to the power system with respect to interconnections, size and location. For instance, it is quite apparent that a power station that forms the chief source of power supply for an area and that does not have reliable interconnections with other power systems warrants more reserve equipment and must have a greater number of steam-driven auxiliaries for starting up the station than a plant forming part of an interconnected system.

Furthermore, it is apparent that if a new station forms part of a large interconnected group of power plants it may be designed and built to operate at a better load factor and thereby reduce the need for adjustable-speed auxiliary drives.

The location of the station will also affect the selection of type of auxiliary drive by reason of the influence of location on the kind of fuel and fuel-burning equipment used and on the space limitations. Gas- and oil-fired, also pulverized-fuel-fired, boilers are somewhat more flexible than stoker-fired boilers and can therefore be taken out of service more readily with changes in load. This favors the use of constant-speed electric drive. If, on the other hand, the bin system of pulverized fuel supply is used, exhaust steam is usually required to dry the coal, thus justifying the use of some steam-driven auxiliaries. Furthermore, if ground and building costs are high and adjustable speed is required, the use of steam-driven auxiliaries may result in an appreciable saving.

The total auxiliary power used by a modern station is a relatively small part of the gross generated power, being approximately from 4.5 to 6 per cent; hence a

large power saving cannot be expected in the selection of auxiliary drives. Likewise, the investment cost of the auxiliary power, including drive and control equipments, is a relatively small part of the total station cost, being in the case cited for electrically driven auxiliaries approximately 7 per cent of the total station cost. It would appear that the station designer is more or less free to use either type of drive without seriously affecting the cost or the efficiency of the power station as a whole. Electric drive for essential auxiliaries is favored from the standpoint of convenience and cleanliness in operation, also because it is more readily adapted to automatic and remote control, particularly in the boiler room.

Maintenance costs would be of interest for a comparison between steam and electric drive; however, representative figures are difficult to obtain, chiefly because sufficient time has not elapsed since the modern stations were placed in operation. In addition, the advancement in station design has been so rapid in the last few years it is difficult to find stations of sufficient similarity to make a fair comparison.

The steam turbine side of the problem was presented in a paper. "Steam Driven Auxiliaries for Power Stations," by W. Poole Dryer, Stone & Webster Engineering Corporation. In his opinion, the degree of reliability required of a generating station is a paramount consideration in determining the method of driving essential auxiliaries in power plants. Secondary considerations are simplicity, initial cost, maintenance expense and economy of power.

A station with motor-driven auxiliaries supplied from a single source of energy would not be as reliable, in so far as the supply of energy is concerned, as the station with turbine-driven auxiliaries. Once the steam energy destined for auxiliaries is transmuted into electrical energy for use in the motors, it enters an additional realm wherein its stability is both more sensitive to disturbance and more subject to unexpected attack. Hence, to attain the same degree of reliability of the auxiliary energy supply as in the turbine-driven station the station with motors must have duplicate sources of energy.

Despite their simplicity and reliability, turbine-driven auxiliaries were to a large extent displaced when it was discovered that a fuel saving could be made if steam for auxiliary power was first passed through the main turbines to produce electrical energy and extract steam for feedwater heating, instead of being passed through small tubines mechanically driving auxiliaries and then to feedwater heaters.

A modern station's net output for a given fuel consumption is increased about 1.75 per cent at maximum load by substituting motors for turbines on all essential auxiliaries and by heating the feed water with extracted steam instead of auxiliary exhaust steam. The over-all thermal efficiency of the station with turbine-driven auxiliaries is about 24.4 per cent and that of the station with motor-driven auxiliaries is 24.8 per cent. The 1.75 per cent advantage in the station in question would be slightly greater if two points of extraction instead of one were used to heat the feed water to the same temperature. Due alone to stray losses encountered in operation, the advantage might be as high as 2.5 per cent. The difference in efficiency of the two stations compared would be much less if high-efficiency auxiliary turbines now obtainable had been assumed instead of the low-efficiency taken as better representing common practice.

To acertain the total difference in power consumption between steam- and electric-driven auxiliaries over the whole working range of the boilers and turbine generators, and hence the net annual saving in fuel, it is necessary to determine the power taken at part loads by both types of drives. This has been done by analyzing separately the power input to each assential auxiliary when driven with tubines, squirrel-cage, and adjustable-speed wound-rotor motors. The results of these analyses are given in Figs. 1 to 5.

These curves represent the performance of equipment in stations having large boilers and turbine generators, where the auxiliary turbines also would be large and slightly more efficient than those often used. However, turbines having higher efficiencies than assumed in this analysis are now in operation on auxiliary service.

It will be seen from the curves that as the boiler and turbine-generator loads decrease from a maximum the relative power consumptions of steam- and motor-driven auxiliaries vary in the following manner:

1. For such auxiliaries as circulating-water pumps and fuel-pulverizing equipment, for which the output is substantially constant throughout a wide range of load on the main units, and for which constant-speed squirrel-cage motor drive is suitable, the electric drive maintains its relative efficiency over the turbine drive throughout the whole range of load.

2. For such auxiliaries as boiler-feed pumps and forced- and induced-draft fans, in which the output varies with the load on the main units, the squirrel-age motor rapidly loses the advantage in power saving which electric drive gives at maximum load, and below about 85 per cent load on the main units it is less efficient than the turbine. At lower loads the initial relationship between the two drives can be reestablished by transferring the load to a lower-speed motor, but on reducing the load still further this motor will in turn become less efficient than the single turbine. The superior economy over turbine drive which the adjustable-speed wound-rotor motor gives at maximum load diminishes greatly as the

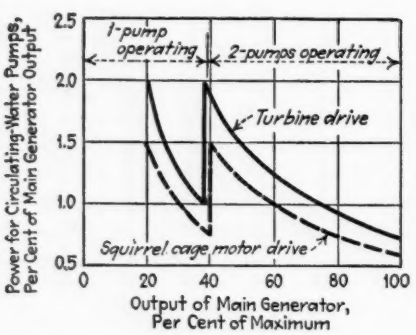

1-pump operating
2-pumps operating
Turbine drive
Squirrel cage motor drive
Power for Circulating-Water Pumps, Per Cent of Main Generator Output
Output of Main Generator, Per Cent of Maximum

Fig. 1—Power required to drive circulating-water pumps

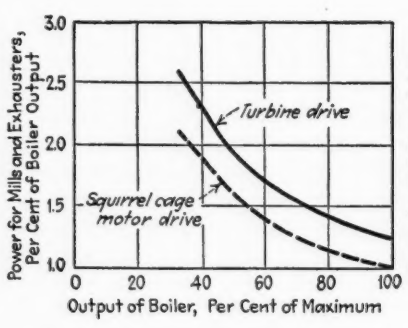

Turbine drive
Squirrel cage motor drive
Power for Mills and Exhausters, Per Cent of Boiler Output
Output of Boiler, Per Cent of Maximum

Fig. 2—Power required for unit pulverizers and exhausters

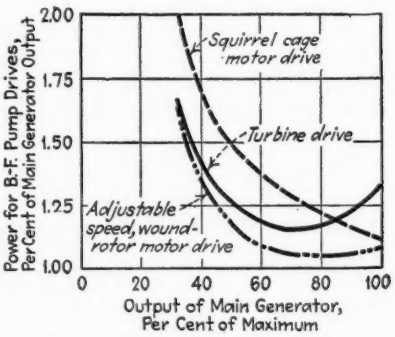

Squirrel cage motor drive
Turbine drive
Adjustable speed, wound-rotor motor drive
Power for B-F. Pump Drives, Per Cent of Main Generator Output
Output of Main Generator, Per Cent of Maximum

Fig. 3—Power required to drive boiler-feed pumps

load decreases and will vanish at low loads unless operation is transferred to an additional and lower-speed motor.

These conclusions indicate that from a consideration of power consumption the most favorable application for turbine drive is on equipment like draft fans, which, having to traverse a wide speed range and load, use more than one motor when electrically driven. Even on this application the electric drive saves power. However, it involves a larger investment in both driving and generating equipment. In plants designed to deliver large quantities of steam for industrial uses or for heating the economic balance is usually in favor of turbine drive.

To realize fully the advantages obtainable by using auxiliary turbines in conjunction with large main turbines more efficient designs and methods of application become desirable, practicable and commercially feasible. With the conventional designs and applications of these machines more stages and larger diameters can be used to raise the efficiency at maximum load; however, care must be taken that the gain so obtained is not at the expense of inefficient partial load operation.

Novel means for securing very high efficiency have been adopted in turbines recently installed in one large central station. Not only have high rotative speeds and many stages of highly refined design been introduced, but the steam is passed in series through the induced-draft-fan turbine and then through the forced-draft-fan turbine.

While the immediate development of the auxiliary turbine will be along lines of higher efficiency and greater refinement of mechanical detail, the development of electric drive should be directed toward greater simplicity and lower installation cost. Greater sturdiness of adjustable-speed motors is desirable, as well as wider speed ranges, but the greater field for improvement is in distributing systems and control equipment. It is desirable to retain the efficiency and convenience of motor drives, without sacrifice of reliability, at substantially lower cost than the systems now in common use require. While it is not clear at the moment how this end may be accomplished, the problem is receiving the attention that it deserves. The great variety of systems adopted in recently built stations indicates that power plant designers are far from satisfied with the conventional auxiliary power systems, and that they are striving to produce something better than has been designed before.

Mr. Dryer's Conclusions

It will be inferred from the foregoing discussion that in the present state of the art the turbine constitutes the simplest and most reliable drive for steam power station auxiliaries. For conditions requiring extreme measures in the protection of auxiliary power supply its simplicity and reliability may warrant the selection of turbine drive for all essential auxiliaries.

For maximum station-load conditions there will be an improvement in over-all fuel economy of the order of 2 per cent incident to the use of motor drive instead of turbine drive for all essential auxiliaries. With both types of drive, steam would be extracted from the main turbine for feed-water heating, more being extracted in the case of the motor-driven station.

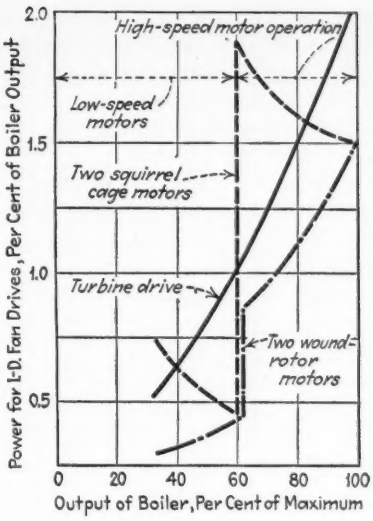


Fig. 4 (Left)—Power required to drive induced-draft fans

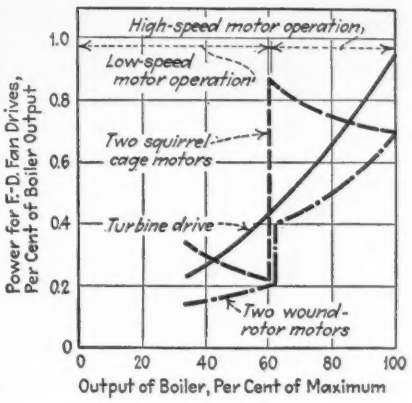


Fig. 5 (Above)—Power required to drive forced-draft fans

For the auxiliaries taking constant power and driven at constant speed the economy due to motor drive is even greater at part than at maximum station loads.

For the auxiliaries driven at adjustable speed the advantage in economy with motor drive is slight at lower loads.

Under most conditions the total annual expense for forced- and induced-draft fans and perhaps for boiler-feed pumps, including fuel costs, maintenance and capital charges, will be less with turbine drive than with motor drive.

There is an element of convenience in starting and stopping which commends the motor drive to the average operator when other considerations are approximately equal.

There seems to be little justification for the use of turbine drive for non-essential auxiliaries (those which may stop for a short time without inconvenience), these auxiliaries being in the main driven at constant speed.

Future developments may change the relative status of these two types of drives, but it would appear that progress in the immediate future will tend to decrease the advantage in fuel economy which the motor now possesses, and to increase the turbine's advantage in reliability.

Electrically Driven Auxiliaries

A review of the history of auxiliaries for steam power stations shows a gradual change from complete steam drive to the other extreme of complete electric drive except for a few reserve steam-driven auxiliaries such as boiler-feed pumps and service pumps. During an intermediate period, dual steam and electric drive was used quite extensively for some of the essential auxiliaries, but the number of dual drives appears to be steadily diminishing. This was the opinion expressed by Lyle W. Smith, Sargent & Lundy, Inc., in a paper "Electrically Driven Auxiliaries for Steam Stations."

The higher efficiency of electrically driven auxiliaries receiving their power from the efficient main turbine or house turbine, as compared with small inefficient turbine-driven auxiliaries, has always been attractive to station designers. However, lack of confidence in the reliability of the early forms of the electric drive for essential auxiliaries retarded its general adoption until more operating experience was obtained and other reasons than efficiency of the auxiliary drive appeared.

The change from steam to electric drive is largely due

to an increasing feeling of confidence in the reliability of electric drive, an increasing appreciation of the simplicity and flexibility of electric drive, and important changes in boiler and turbine practice. Confidence in electric drive has been strengthened by improvements in the manufacture and application of electrical equipment; the proved value of station and system interconnections; and a record of successful operating experience.

The selection of the type of drive for a station's auxiliaries is not usually made as a result of a direct comparison between the cost and performance of a motor and a turbine alone, but is also determined to a large extent by the general design of the plant. A comparison between steam and electric drive introduces two factors that are the subject of considerable debate. One of these is the cost of an electric auxiliary power supply that can be considered equally reliable as steam drive, and the other is the actual water rate of small steam turbines.

Operating experience with small steam turbines indicates that their efficiency falls off very rapidly unless they receive considerable maintenance. Cases have been reported where the efficiency of small turbines has dropped to half of the guaranteed efficiency because of lack of maintenance. It is apparent that any comparison between electric and steam drive should take this characteristic of the small turbine into consideration. even though it may be difficult to evaluate.

The amount of power required for an electrically driven auxiliary system is relatively small and depends to a large extent on the type of fuel-burning equipment used. The station load factor and nature of condensing water supply also affect the amount of auxiliary power to a lesser extent. A few typical values of auxiliary power with different types of fuel-burning equipment are given in Table I.

TABLE I — TYPICAL VALUES OF AUXILIARY POWER

Fuel-Burning Equipment	Per Cent of Total Auxiliary Power
Pulverized coal	5.5 to 6.5
Stokers	4.0 to 5.0
Gas and oil	3.5 to 4.0

The subdivision of auxiliary power for a modern 650-lb. steam generating station of approximately 200,000-kw. capacity, entirely equipped with electrically driven auxiliaries and using the unit system of pulverized-fuel equipment as expressed in per cent of the total auxiliary power is approximately as in Table II.

TABLE II — POWER REQUIRED FOR AUXILIARY DRIVES IN A LARGE MODERN PLANT

Equipment	Per Cent of Auxiliary Power
Coal preparation	22.0
Boiler-feed pumps	22.0
Turbine auxiliaries	22.0
Forced- and induced-draft fans	20.0
Heater-drain pumps	3.8
Service pumps	2.6
Station lighting	2.4
Coal handling	1.6
Miscellaneous auxiliary power	1.5
Ash-sluice pumps	1.0
Air compressor	0.7
Dust precipitators	0.4
Total (5.5 per cent of gross generated power)	100.0

Table III gives the major subdivisions of investment cost for the electrical part of the electrically driven auxiliary system, Table II. This station utilizes two 4,000-kw. shaft generators, and two 9,000-kva. transformer banks connected to the main bus for auxiliary power. The main switching equipment and the 2,300-volt auxiliary switching equipment are of the vertical-lift metal-clad type. Air circuit breakers and magnetic switches are used for 440-volt motors. The boilers are equipped with full automatic control. The investment costs are expressed in approximate percentage of the total station cost.

TABLE III — INVESTMENTS IN ELECTRICAL EQUIMENT TO DRIVE AUXILIARIES

	Per Cent
Prorated share of cost for turbine-generator units used for auxiliary power	0.8
Auxiliary power distribution system, including transformers	1.0
Motors	1.2
Control for motors	2.0
Cable and conduit for motors and control	2.0
Total	7.0

In Table III only the prorated share of the cost of turbine-generator units used for auxiliary power is included, because the boilers and the balance of the station equipment are common to both steam and electrically driven auxiliary systems. No allowance has been made for space occupied by electrical auxiliary equipment, because it would be approximately the same for either type of drive. The main auxiliary transformers and high-tension switching in this particular case are installed out of doors. The flexibility of electrical control equipment enables it to use space that might otherwise be wasted.

Conclusions on Electric Drive

Mr. Smith summerized the chief advantages of electric drive over steam drive for station auxiliaries as:

1. It facilitates an efficient station design by permitting all of the steam required for feed-water heating being taken from the main turbine by stage bleeding.
2. It may be approximately twice as efficient in terms of British thermal units per kilowatt-hour as steam drive with small turbines, depending upon the amount of maintenance received by the turbines.
3. It is uniformly efficient, because lack of maintenance does not materially affect the efficiency of electrical equipment, although it may reduce the reliability of the equipment somewhat.
4. It requires less maintenance.
5. It is simpler to operate.
6. It improves the physical design of a station and its operation by reducing the amount of auxiliary piping required, particularly in the basement.

Some of the possible methods of reducing the cost of an electrical auxiliary system are:

1. Obtain auxiliary power supply from transformers connected to the main generator leads ahead of the generator oil circuit breakers, and a reserve supply from the bus, if reliable interconnections are provided with other stations and the station bus is protected by reactors or the equivalent.
2. Establish both high-voltage and low-voltage auxiliary power distribution groups central to location of auxiliaries instead of in electrical bay, thereby reducing length of cable and conduit runs.
3. Increase the horsepower range of low-voltage motors in view of relatively high cost of high-voltage control equipment.
4. Diversify feeds to all duplicate auxiliaries where possible, thereby permitting simpler switching layout for adequate maintenance.
5. Use squirrel cage motors and full-voltage starting equipment wherever possible even at sacrifice of a small percentage of station efficiency.
6. Use factory fabricated control equipment wherever possible.
7. Use armored cable, grouped in metal troughs or large pipes for auxiliary power and control when installed indoors or parkway cable when installed out of doors.

In opening the discussion on the papers A. H. Kehoe,

electrical engineer, United Electric Light & Power Company, reviewed the experiences with both steam- and electric-driven auxiliaries at the three major stations in the metropolitan district—Hell Gate, East River and Hudson Avenue. From a standpoint of reliability and flexibility of control, he said equally good results have been obtained with both drives.

I. E. Moultrop, chief engineer, Edison Electric Illuminating Company of Boston, was of the opinion that no definite stand could be taken on the question and that in the light of recent experiences both types of drive had their proper place in any plant. He did however favor the steam turbine drive for boiler-feed pumps, not only from the standpoint of reliability, but because the use of turbine drive permitted the best pump design. He said there was a need for a simpler and better valve control mechanism for the small turbine and with respect to the electric drive there was need of improvement in design of the control used with variable-speed motors. He thought the present control equipment too costly and too bulky, often requiring more space than the motor. He expressed a need for closer cooperation between central station designers and motor designers.

Definitely favoring the electric drive, H. M. Cushing, chief engineer, Buffalo General Electric Company, stated that as a result of the experience with both types of drive in Huntley station No. 1 all auxiliaries in Huntley No. 2 are electric-driven with the exception of two auxiliary oil pumps on the main turbines, which were furnished by the turbine manufacturer. It was his opinion that not only is electric drive more reliable, but it is simpler to operate. He added that many of the auxiliary turbine drives originally installed in Huntley No. 1 had been replaced with motor drive with a view to reducing maintenance costs. In general 550-volt motors are used.

In a written discussion, which owing to lack of time was not presented at the meeting, J. H. Lawrence of Thomas E. Murray, Inc., pointed out that there is not any one general answer to the problem of making a decision between electric and steam drive any more than there can be any one answer to the correct steam pressure for any station. For instance, a steam plant designed to act as stand-by for a hydro plant must be treated differently from a steam plant that is to operate continuously. Although the use of electric drive for auxiliaries was given considerable impetus with the advent of stage bleeding, the efficiency of the small turbine has been so much improved, since that time, that today it is a mooted question as to whether steam or electric drive should be used. To get equal reliability the electrical system is more costly. He was of the opinion that the heat efficiency of a station with steam auxiliaries can be brought within 1 per cent of the station with electrical auxiliaries, or about one-half the difference quoted by the authors.

If we assume that many of the auxiliaries, such as circulating pumps, coal pulverizers, etc., should run at constant speed, we lose the advantages coming with variable speed. The circulating pumps use considerable power, and a large saving can be made by slowing down the pumps as the temperature of the water drops. Also, it has been found that variations in characteristics of coals justify a variation of speed to get the best results from some coal pulverizers. If the advantages of variable speed are neglected the efficiency of the electric drive may show up very favorably, but the heat efficiency of a station with properly designed steam drive should show very little loss over electric drive, certainly not more than 1 per cent.

He was of the opinion that the cost of the electric drive with its prorated share of the station cost will be so much in excess of the station with the steam drive that for the average generating plant steam will be found to be more economical in overall costs. Also, with equally good designs of the two systems, he does not believe the efficiency of the electric drive can be improved to an extent that this extra cost could be justified unless the capacity factor is higher than usually found in a central station.

▼ ▼ ▼

Precooling Core Water

By M. F. KNOY

ANYTHING which shortens the ice-freezing time makes for plant economy, since it permits of higher tank temperatures. Precooling the corefilling water is a factor tending to this end, which is sometimes overlooked.

The rate of heat removal from the center of the can becomes increasingly slower as the outer shell of ice gets thicker. For this reason the last few pounds of water in the core freeze very slowly. Where fairly large cores are pulled it will often require 10 to 12 hr. for the core to freeze up. If the cores are filled with 80-deg. water there will be required the removal of 192 B.t.u. per pound to convert this water into ice. If the corefilling water is cooled to, say, 40 deg. only 152 B.t.u. of refrigeration per pound will be required in the tank. The freezing time after coring will thereby be shortened to 152 or only 79 per cent of that needed with 80-deg. water. Thus if it requires 12 hr. after coring with 80-deg. water to finish freezing it will require only 12x0.79, or approximately 9.5 hr., with 40-deg. water.

Strange as it may seem, this is a greater reduction in freezing time than can be accomplished by precooling the entire 300 lb. of original can water. From several tests the writer has found that 80-deg. water when placed in the cans will drop to the freezing point in about 30 min. This proves that the warmth of the water could only delay freezing by about that amount of time. This is explained by the fact that the heat transfer from the warm can water to the brine is very rapid, due partly to the great temperature difference and partly to the excellent heat conductivity of the thin can wall. After the layer of ice in the can becomes several inches thick the rate of heat removal will be slower. Hence a small additional quantity of heat introduced with the core water will require a great deal of extra time for its removal.

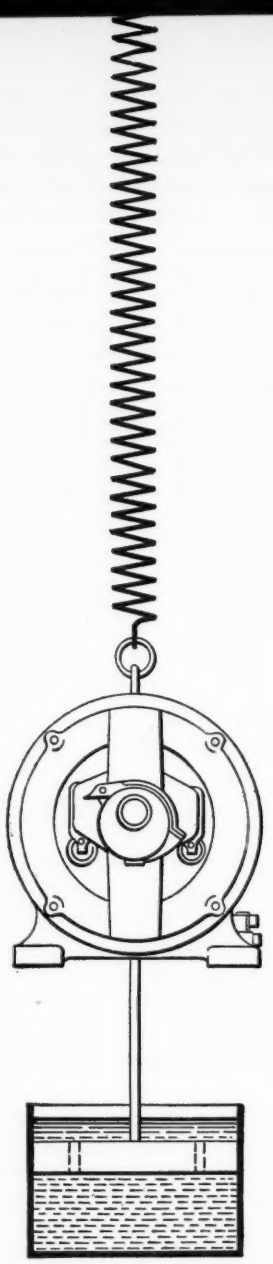
Since the actual amount of water required for core filling is comparatively small, the equipment required to precool it will not be expensive. A small insulated tank equipped with a direct-expansion coil will be sufficient. Very little room will be required for such a cooler, and in view of the reduction in freezing time accomplished it usually proves a good investment.

How To Smother Vibration

TOLD IN PLAIN ENGLISH

By ARTHUR H. ADAMS
Consulting Engineer
New York City

Vibration is nobody's friend, but the engineer's baby. What to do? The mathematical approach to this problem is a fine tool for those who understand it. Those who don't — and this includes most engineers — can solve the majority of their vibration problems by a common-sense application of well-known isolating materials. Read how



This doesn't resemble a commercial motor installation, but it shows the essentials of vibration isolation—a long "soft" spring plus "hydraulic" friction damping

THE DEMAND today is insistent that all the machines and products of our mechanized society be subordinated to the safety and comfort of man. We may use Robots, but we now demand of them quiet and respect for our nerves, as well as efficiency and safety. Hence the importance of vibration isolation.

There have been many mathematical studies on elastic suspensions, resonant frequencies and damping. This will be just a few plain statements for the practical man as to the practical meaning of the laws and formulas in which recent technical literature abounds.

Hums, Squeals, Rumbles, Rattles and Blows

There are wide ranges of vibration to be contended with, from high-pitched hums, squeaks and squeals at the upper limit of audibility to the low rumbles and single shocks that are mainly felt and not heard. There are mechanisms to be isolated from their mountings or from buildings because they themselves emit vibrational energy. There are delicate instruments and mechanisms that must be isolated from the vibrations and shocks of all kinds coming from the outer world.

To some extent each problem is different. If each could be thoroughly studied one best solution would be found for each. But if we must wait for the ideal instead of applying the 90 per cent solutions available, our Robots will remain impudent a long time.

Luckily, isolation, like electrical insulation, works both ways, and the same remedies apply whether we are isolating the sinner or the victim. Luckily also, practically speaking, the same general kind of remedy is helpful for all frequencies and energies.

These notes, it will be understood, refer only to vibration transmitted through solids, not to vibration in air, or sound.

The problem is usually treated in two stages, or as two questions:

There Are Two Problems

A. **Given a source of vibrational energy of known frequency, what is the best barrier to interpose between that source and adjacent solid bodies?** This is rarely the practical man's problem. It is the problem that has received the most mathematical study.

B. **Given a wide band of unknown vibration frequencies, what is the best barrier?** This is the practical problem. Theory here has hardly kept ahead of practice.

The answer of physics to problem A is relatively clear. In plain English: **Support the unit or mass to be isolated entirely on elastic cushions or springs so yielding or soft that the natural vibrating or dancing rate of the mass so supported will be much slower (4 to 10 times) than the known frequency to be isolated.**

The heavier the object to be isolated the slower will it dance on given springs. But also, the heavier the object the heavier the springs have to be to carry it. The weaker the springs the slower a given suspended weight will dance. The longer you make springs of given cross-section, the slower a given suspended weight will dance.

Where the problem justifies the work the engineering method calculates the desirable stiffness and length of springs from the known mass of the isolated body and the known frequency of the disturbing impulses. This is altogether the best way, where justified.

But after all what is needed is always the equivalent of a very long spring, one that will stretch or compress a long way with a small force. If it is too long, no harm is done. It must, naturally, be a thick enough spring to carry the load. If the unit to be isolated weighs a ton the spring or springs must be heavy enough to support a ton with a margin of safety. And, naturally, the thicker and stronger the springs the longer they have to be to be yielding enough.

Speaking of Bird Cages

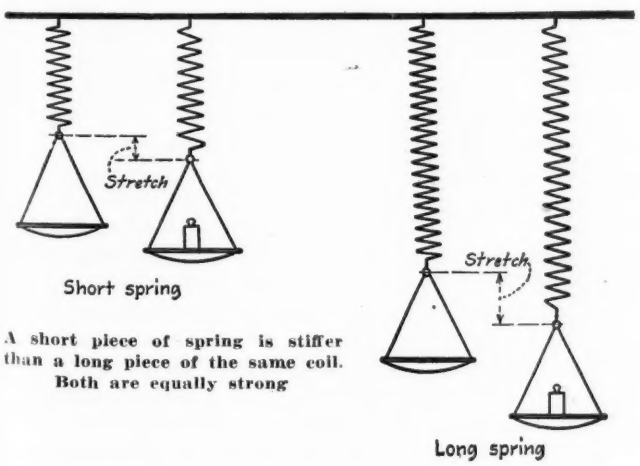
Do you remember the old bird cage hung on a long spring so it would sway and dance and give the canary exercise and maybe the impression of wind swept boughs? Suppose you loaded the cage with sand, to twice the original weight. The spring wouldn't stand it. So you use two springs, or one twice as strong. Now, when you sweep out the sand, your cage dances twice as rapidly as before. This makes the canary dizzy and the new spring or springs have to be made about twice as long as the original to get back to the same old natural period or rate of dancing. Simple, after all, isn't it?

The trouble usually is that it is not easy or pleasing in appearance to put the equivalent of a long enough spring in the space available. The killing of vibration usually is left to luck and to plenty of metal. Adequate space is always hard to find after the job is done.

Very thick, live, soft rubber pads, except for their tendency to harden, are often the most practical expedients for a problem of the A class.

Were it not for obvious practical limitations in its application, a partly inflated inner tube would make an ideal elastic supporting pad for a motor-generator set or similar machine. The same would be true of a large metal bellows, sealed full of air while well extended.

If there are several known disturbing frequencies to attack, the suspension needs to be soft enough to make the natural period of the suspended unit several times as slow as the lowest disturbing frequency.



A short piece of spring is stiffer than a long piece of the same coil. Both are equally strong

The answer to question B is more difficult to give briefly, more generally useful, but never as perfect an answer theoretically.

We wish to stop the transmission, into or out of some unit, of all kinds of vibrations, of many and unknown frequencies, and also of shocks or knocks. We have to contend with machines of all kinds involving elements rotating and reciprocating at different speeds, gear rattles, motor vibrations, irregular vibrations and chatterings of materials being stamped, cut, sawed, crushed, distorted; vibrations from street and rail traffic; elevator accelerations and "decelerations," etc. The sources are usually too many and the frequencies and energies too variable to analyze at a reasonable cost.

Were it physically possible or practicable to use such extraordinarily soft and yielding suspensions as to give an isolated unit a natural period much slower than the slowest of the unknown disturbing frequencies, it would be solved by the methods of question A. The inner tube scheme isolates very well almost any vibration, because it is so extremely "soft." But such soft suspensions are impossible in most cases.

Your Car is a Good Example

The best known practical case of the all-around problem of isolating against all kinds of periods and jars is exemplified in your automobile with its pneumatic tires, spring suspension and hydraulic or other shock absorbers. Your road experience will tell you that there cannot be any one perfect answer. Some speed and spacing of stones or holes on the highway will set it bouncing and swaying.

But if theory and common sense agree that there is no perfect isolation, proof against all jars, rattles and squeaks, they also agree that these disturbances can readily be cut down so greatly, and by simple methods, that these methods may practically be called good cures. You feel bad roads at 40 miles an hour more than smooth concrete in the easiest riding car. But our grandfathers felt them far more in their ox carts at 4 miles an hour.

Incidentally, while the disturbance to human nerves is the most cogent sales argument for silencing our Robots, it is further true that in most cases the absorption of vibration and shock will pay well in dollars and cents by the saving of wear and tear, and by better work.

The Answer is a Soft Support Plus Friction

The answer of theory and of practice to question B is then briefly this: **Use a "soft" suspension (long and flexible springs on your car) and use friction or damping with it (good shock absorbers).** But this answer needs amplification.

There are several kinds of friction. The hydraulic kind has one valuable peculiarity for our purpose: It is greater the swifter the motion and it practically disappears when the motion is very slow. That makes it the ideal type of friction as a damper for very yielding or "soft" elastic suspensions, in that it permits the suspension to return finally, though slowly, all the way to its original position after every deflection.

The bigger the friction or damping the better, within reason, for the majority of cases, provided it is of this hydraulic friction type. Usually the greatest vibrational energy, causing the biggest disturbance to people and instruments, is in the relatively low frequencies. While it is easy to make the natural period of your suspended

or isolated unit slow enough to be undisturbed by the high frequencies, you cannot practically get below some of these most disturbing low frequencies. These have to be killed by the friction, or "damped out."

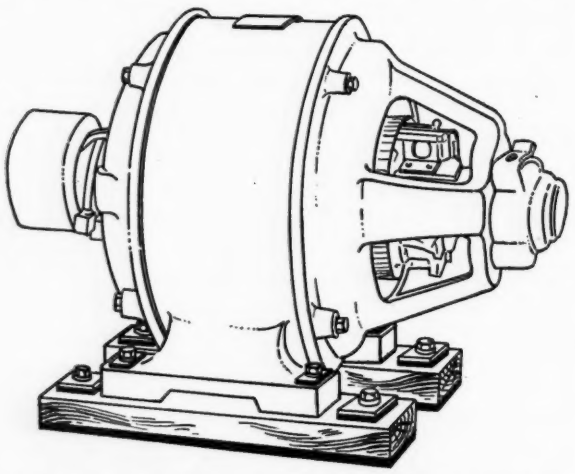
The needed elastic suspension plus friction may be specially designed like your automobile suspension, using springs or rubber or some purely springy material for the one element, and dashpots, rubbing pads of felt, leather, etc., for the other element.

Cork, Rubber and Synthetic Pads

For general purposes, however, the neatest and least obtrusive and most practical isolation methods have latterly depended on the combined internal friction and elasticity of certain materials. Of these the outstanding choice, until very recently, was cork, preferably in natural form. Cork is quite elastic, reasonably "soft"—it yields materially under small pressure changes—and has a higher internal friction than any equally soft resilient natural material. It is fairly permanent and resists most solvents and a fair degree of heat.

Soft rubber is elastic and "soft"—much "softer" than cork—but it has not high enough internal friction or damping and needs to be supplemented by friction devices or used alternately with cork, for general work. It can be obtained readily in any desired shape. It has the defect of becoming oxidized and hard after some time and of being attacked by oil and some other solvents.

A synthetic type of material developed in Germany and used there for some years has recently come on the market. The material, designed specifically as a vibration isolator, is elastic, as "soft" as most soft rubber,



Method of applying rubber or synthetic isolant to machine. With non-compressible isolants (like rubber) the contact surfaces should be broken up by slots or otherwise

with two to three times the internal friction or "damping" of cork, is very permanent and quite oil-proof. The damping or internal friction has generally hydraulic characteristics. These new materials, unfortunately, will not resist temperatures as high as cork, or even rubber, and are affected by prolonged contact with water. For the general field they seem to offer the designer a means to obtain far better isolation in less space than any earlier material or combination, in those cases where they are not exposed to frequent wetting or to heat above 140 deg. F. They can apparently be produced in almost any shape, like rubber. The present commercial forms are large sheets of $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$ in. thickness.

There are available various built-up or combined isolating materials. Ground cork cemented into blocks; hair and other felts impregnated with viscous materials; elastic felts given damping by mixture with lead wool; and sandwiches of felt and cork. There are several successful designs of anti-vibration supporting units comprising metal springs and/or felt pads.

For general use by practical men, to do a cheap practical job of isolating troublesome but unanalyzed vibrations, the best available materials are cork and the synthetic product mentioned.

Some apparently obvious considerations in the application of isolation materials are often overlooked. For example, it is vital to remember that just as in electrical insulation if a body is not completely isolated it is not isolated at all. Cases have been known of machines supported on cork or other isolant, but with lag screw heads clamping down, metal to metal, or with stiff conduit pipes rigidly connected, thereby transmitting the vibration to or from the floor or walls and making the isolant pads nearly useless. Even the side contact of a lag screw in a hole or slot will transmit much vibrational energy. **Isolate completely or not at all.**

What Loading is Best?

The suppliers of isolants give data as to methods of use and allowable loads that should in general be followed when figuring areas of pads. For natural cork somewhere around 10 lb. per square inch is a good figure. For the new material up to 30 lb. is claimed. The writer believes this is much too high, unless only low frequencies are involved. (See below.) Some soft rubbers can be used up to 40 lb. per square inch. Use slightly lower loads than the recommended maxima whenever possible.

If forced to figure loads closely, do not forget to consider how far belt pulls, etc., if any, increase the pressure on certain feet of the machine.

The area of pad to use should, then, be large enough to give loads preferably somewhat under the recommended maximum. But, also, economy demands that the area should not be many times larger. This is not only because a large area is itself wasteful if not needed, but because a large area is the equivalent of a strong spring on your bird cage, and we saw that as we made the spring stiffer or stronger in cross-section we had to make it longer. If your cork pad is twice as large in area as necessary permanently to support your machine without settling you will have to make it also twice as thick to get equally good isolation, and thus you will be using, not twice, but four times the volume you need.

How Thick a Pad?

The thickness of isolant pad to use is dependent on the quality of isolation desired. Let us consider again our simple spring suspension: a bird cage on long helical springs. The springs, whatever their length, must be heavy enough in cross-section to support their load without permanent yield. The equivalent of this statement, in the isolant pad, is that just made above, that the pads must have areas big enough to support their loads without permanent compression. With a given cross-section, the longer we make the helical springs upholding our galvanometer, or bird cage, the "softer" they will be and the slower will be the natural dancing rate.

This means, by the principles of the type A problem, that the longer the springs the fewer those disturbances will be having a slow enough period to set the system vibrating. And long springs, of course, are the equivalent of thick pads of isolant.

The upper limit of thickness is set by cost, space, ap-

It Boils Down to This

Support the object to be isolated solely on pads of isolant large enough in area to keep the pressure per square inch within manufacturer's recommendations, well within if possible, but don't go to extremes. Hold the object down with other pads if vibration is strong or of high pitch. Take side or end thrusts on similar pads, if large. Let nothing else rigid touch the object, not even a screw or a conduit pipe.

If a purely elastic isolant without good internal friction is used (rubber, springs, or air bellows), friction must be added. One way to do this is to combine cork or the new synthetic material with the springs or rubber, placing one above the other (for example rubber and cork in alternate layers). For superior results make the thickness or softness of the pads as great as possible, remembering that ½ in. of rubber or of the new synthetic material is as soft as from 3 to 5 in. of cork.

If rubber is used, make the pads easily replaceable, for it will harden in time; also protect from oil. If the new synthetic is used, protect against too frequent wetting and from heats above 140 deg. F. If cork is used, make the pads 3 or 4 times as thick as for rubber and the synthetic material. If results are disappointing, change the natural period by thickening pads slightly or reducing area slightly.

pearance and any necessity for a nearly fixed and rigid position of the machine or unit isolated.

One of the advantages of rubber and of the new synthetic isolants over cork and felt, etc., is that they are so much "softer" than available cork or felt materials that pads can be $\frac{1}{6}$ to $\frac{1}{10}$ as thick, or, if equally thick, are equivalent to a spring 6 to 10 times as long.

Now here is a "joker." After you have followed the above instructions, and have your machine or galvanometer room supported on pads of isolant adequate in area (but not too big) and of such thickness as you guess will give good results (say 3 in. of cork or $\frac{3}{8}$ in. of the new synthetic), you may find that conditions are not much better, maybe even worse. This will happen once in a hundred or so cases. This simply means that, by chance, the mass of your supported unit on the pads you have provided happens to have a natural frequency nearly or fully in tune with some one of the strongest of your unknown disturbing vibrations.

Had a physicist measured all these disturbances and calculated the suspension correctly, this would not have happened. But the practical remedy is simple. Just change the natural frequency a little.

You can do this by lightening the unit, or, better, by weighting it a little. You can do this by increasing, or, better—if the load per square inch is not already pretty high—by decreasing the area of your pad. You can do it by decreasing, or, better, by increasing the thickness of the pad. If your canary has a habit of hopping from perch to perch regularly just in time with the natural dancing of his cage, you'll have to lighten or weight the cage, use a stiffer or weaker spring of some length, shorten or lengthen the spring [or get a new canary—Editor]. The easiest and cheapest way is the best to adopt. In general, thickening the pad is recommended.

Unlike cork, springs, felt and air bellows, the new synthetic material and rubber are not compressible. Now in using a compressible material it makes little difference how large may be the unbroken area of a pad. But with an incompressible material, as will be shown, it is very important—especially in absorbing the higher frequencies—to proportion individual bearing areas to thickness.

In effect, since materials of this kind cannot give, except by distortion or elastic flow, it is clear that they absolutely require room to flow aside quickly and easily when the transient pressures come on them.

To illustrate: If an unbroken sheet of $\frac{1}{16}$-in. soft rubber is snugly gripped in a smooth-jaw vise it will take very high pressures to close the vise further, because the rubber must flow out at the edges, against the friction of the jaws. The "feel" will be solid. If this same sheet be cut into narrow strips spaced a trifle apart, or punched full of holes, or if the vise jaws are full of deep corrugations, frequent spaces are available into which the rubber under pressure will elastically flow, and the "feel" will not be solid.

Rule-of-Thumb for Non-Compressible Materials

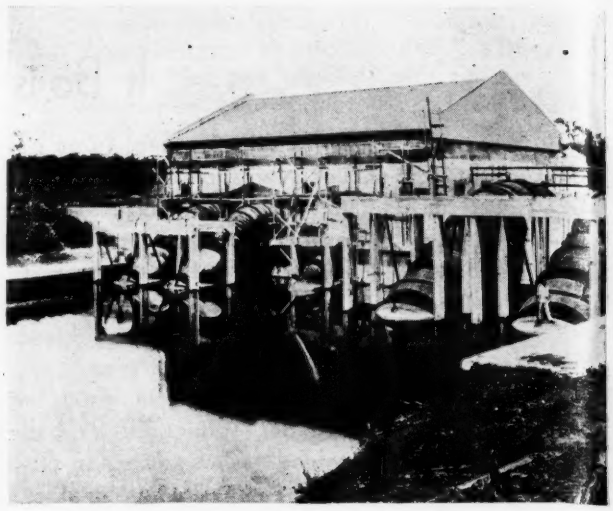
The final rule-of-thumb, then, for rubber and for the new rubber-like synthetic only, is that for every square inch of pressure surface on the pad there should be from $\frac{3}{4}$ to $\frac{1}{8}$ of a square inch of "relief" surface, such as unconfined edge surface, or top and bottom surface not in contact with the load. Altogether safe practice would stick to the larger figure of $\frac{3}{4}$ to 1 in. This would be good for both high and low frequencies.

Thus a long, narrow rubber pad $\frac{3}{8}$ in. thick should be not much over 1 in. wide for best any-frequency results, or should, if wider, be perforated with frequent holes or in contact with pressure surfaces with deep grooves.

However, speaking practically, when the vibrations to be isolated do not include any strong high frequencies, say above 200 cycles per second (and this is 90% of the time), this ratio of free to confined surface may be cut down from $\frac{3}{4}$ to 1 in. as far as $\frac{1}{4}$ to 1 in., or even farther. But not for high frequencies. To rapid vibrations a pad of this class with a large unbroken pressure area will act much like a hard solid.

The writer is convinced that if proper ratios of free to confined area were always used the at-present recommended or practiced maximum loads for these incompressible isolants, (certainly where vibrations of 200 cycles per second or higher are of strength to matter) should be materially reduced, say to about half of present practice or, specifically, to between 10 and 15 lb. per square inch for the new synthetic material.

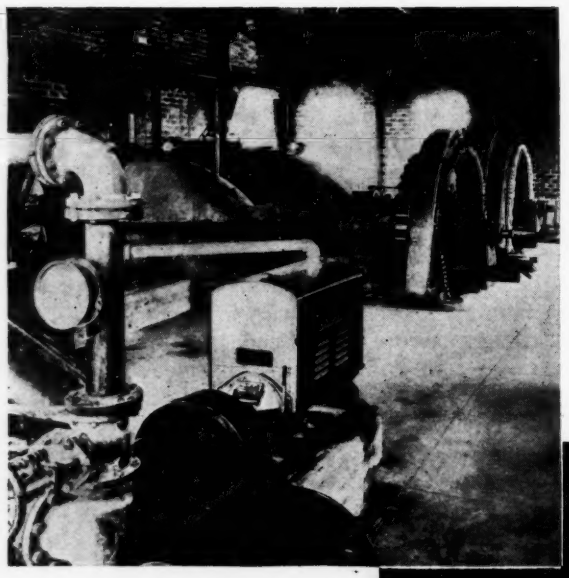
Vibration isolating practice with non-compressible or flowing-type isolants is quite new. There has been as yet insufficient recognition of the essential difference between these and the compressible isolants, which fact has resulted in too closely following the practices found best with cork and the compressible isolants.



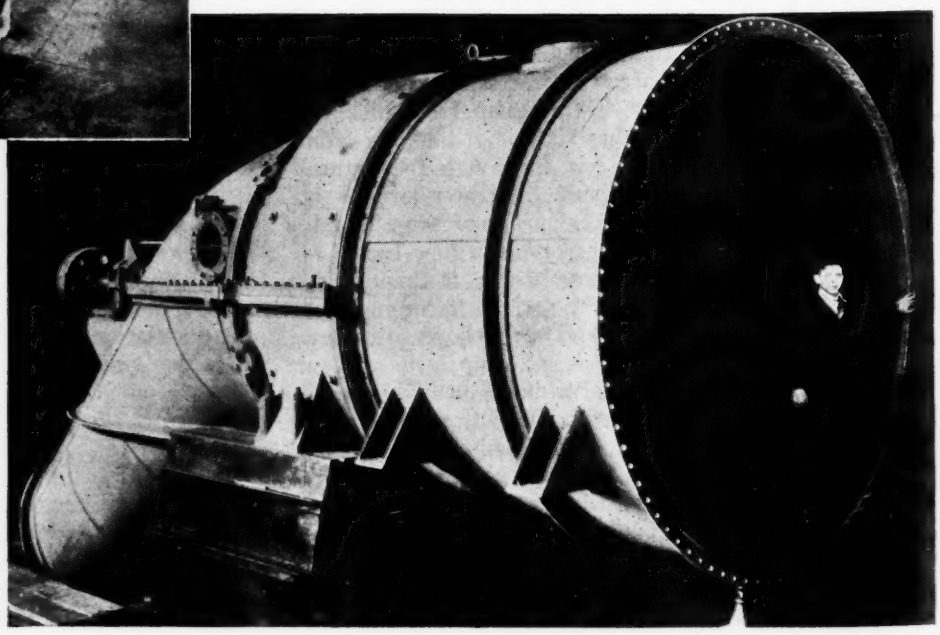
Exterior of Lennox pumping station. The discharge for the pumps is on the left and the two 14-ft. syphons are on the right. The two Wood screw pumps in this plant each have a capacity of 180,000 g.p.m. under a 7-ft. head. They were designed by the Sewerage and Water Board of the City of New Orleans under patents of A. B. Wood, mechanical engineer in charge

NEW ORLEANS DRAINAGE PUMPS HAVE 180,000-G. P. M. CAPACITY

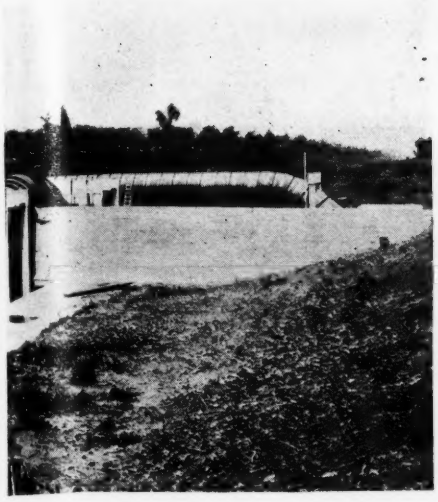
THE ground level on which the City of New Orleans is built is so low that proper natural drainage cannot be obtained. This problem has been solved by pumping all drainage into Lake Pontchartrain and Bayou Bienvenue. On this drainage system are some of the largest low-head pumps in the world. In the new Lennox station there are two Wood screw pumps, a centrifugal pump and a system of four syphons, the largest of which is 14 ft. in diameter.



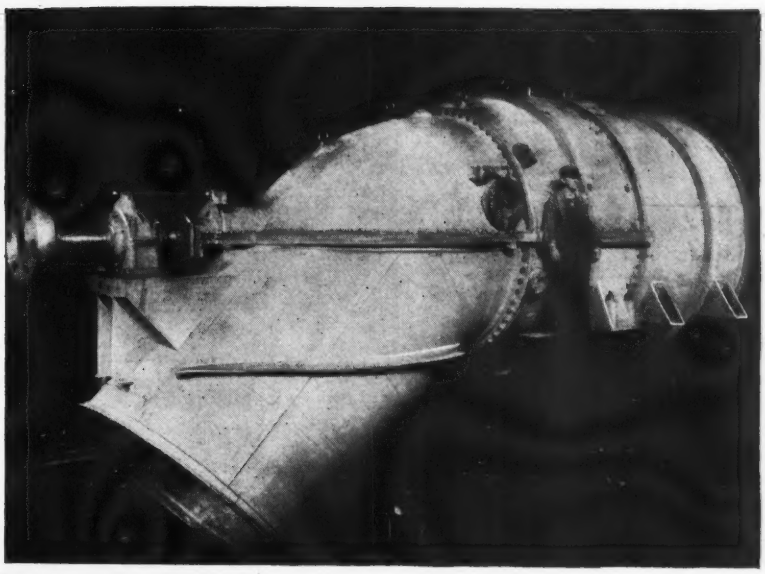
Interior of Lennox pumping station. The two 180,000-g.p.m. drainage pumps are each driven by a 425-hp., 6,600-volt synchronous motor

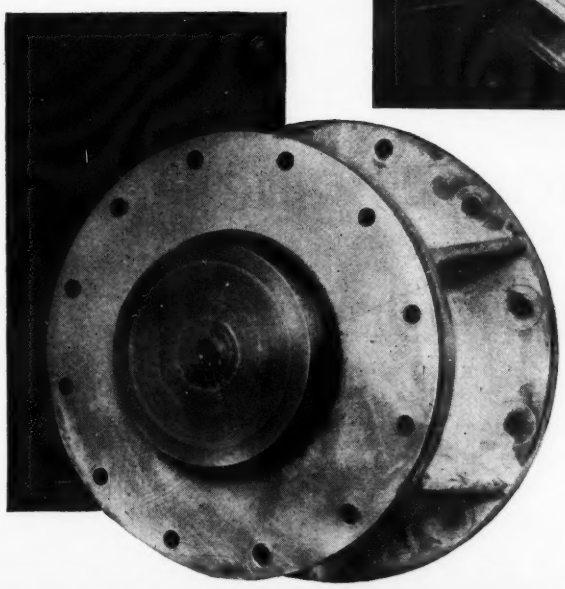


Looking into the discharge end of the casing for one of the screw-type drainage pumps. This casing is 10 ft. in diameter

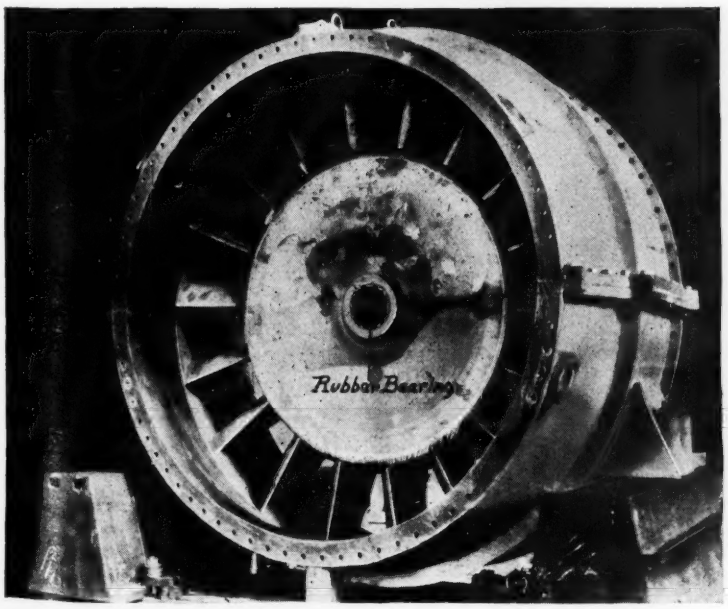


Shop view showing the assembly of one of the Wood screw drainage pumps for Lennox station. Power to drive these pumps is supplied from the Sewerage and Water Board's 30,000-kw. steam plant in New Orleans and an 825-kw. emergency diesel-engine plant in Algiers





Detail view of Goodrich cutless rubber bearing on the shaft for one of the drainage pumps. These pumps are especially designed to handle large quantities of water. Each pump has an impeller 110 in. in diameter carried on a shaft 9 in. in diameter. This shaft is supported on a rubber bearing 33 in. long like that shown in the figure



Pump casing in which the rubber bearing for the impeller shaft is supported. The housing in which the rubber bearing is carried is supported radially by diffusion vanes. These vanes also tend to direct the flow of the water to the 110-in. impeller. The load on the rubber bearing carrying the impeller shaft is approximately four tons. This picture shows a view looking from the suction side of the pump with the runner removed

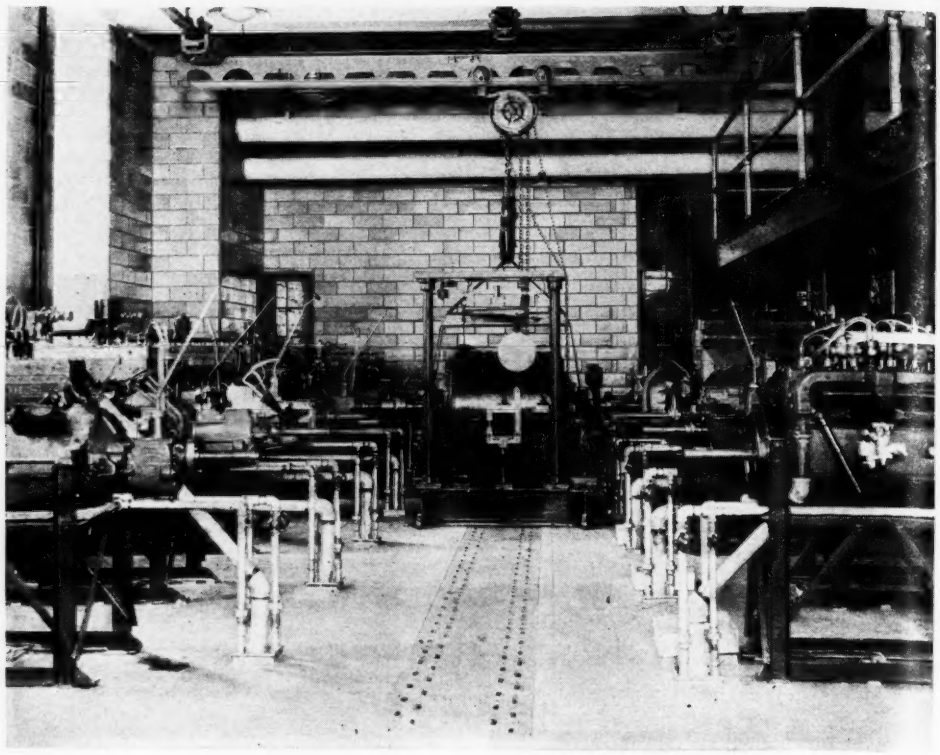


Fig. 1—The gasoline engines in the laboratory, with the dynamometer between the rows

Internal-Combustion Engines at Lehigh University

By G. B. THOM
Mechanical Engineering Department
Lehigh University

IN EQUIPPING the James Ward Packard Laboratory of Electrical and Mechanical Engineering of Lehigh University, which was formally opened in October, 1930, due attention was paid to the trend in engineering development. As a consequence an internal-combustion engine laboratory was incorporated in the structure.

The equipment at present consists of two solid-injection two-stroke-cycle diesel engines of approximately 100 hp. each, a 5-hp. two-stroke-cycle semi-diesel engine, a small gas engine, and a battery of fourteen modern gasoline engines, no two of which are alike in construction. The assortment includes passenger car, truck and airplane engines of four-, six- and eight-cylinder designs, with vertical, radial and inclined cylinders, in sizes ranging from approximately 40 to 150 hp. Power output is absorbed and dissipated in three general ways: by Prony brake and small fixed Sprague dynamometer with air-cooled grid resistors for semi-diesel and gas engines, by a fixed Froude water dynamometer for the diesel engines and by a portable 150-hp. Sprague dynamometer using air-cooled grid resistors for the gasoline engines.

The installation of these engines deviates little from the practice of some years back. The engines are mounted on sturdy concrete foundations and may be loaded either by means of a Prony brake or a small rigidly mounted Sprague dynamometer with suitable resistance grids for varying and dissipating the load.

The diesel engines, Fig. 2, one a two-cylinder 100-hp. engine and the other a four-cylinder 120-hp. engine, both of the two-stroke-cycle solid-injection type, are connected alternately at will to the Froude water dynamometer through a silent chain coupling as shown in Fig. 3. To preclude the possibility of the two engines being accidently connected to the dynamometer at the same time, only one chain was purchased, although two complete sets of sprockets were purchased and installed. This permits of rapid change from one engine to another and yet incorporates a safety feature indispensable in a shop where relatively inexperienced men are permitted to assume the responsibility of testing large laboratory engines. Both couplings are inclosed by stationary

guards which serve a double purpose, protection for the operators and a reservoir for coupling lubricating oil.

The foundation for the engines and dynamometers was poured in one piece upon a four-inch pad of sand laid directly on the subsoil beneath the ground floor of the building. A three-inch clearance space was provided around the entire engine foundation, which space was later filled with a mixture of sand and cinders. The purpose of these mats was to prevent, as far as possible, transmission of engine vibration into the building itself through adjacent column foundations and retaining walls. In finishing the flooring, the engine foundation was insulated from the surrounding existing concrete floors by means of standard quarter-inch waterproofed expansion jointing, thus maintaining complete isolation while permitting frequent washing of the laboratory floor with no danger of erosion of the subsoil surrounding the foundation.

All water-supply, drain and exhaust-gas piping is carried below the floor level and, when necessary, through the foundation through simple expansion sleeves, and is connected to the engines with a minimum of visible exposure, the thought being that in addition to enhancing the appearance of the laboratory such an arrangement centralizes the students' attention upon the engine to be tested rather than upon less important details.

Exhaust gases pass from the exhaust manifolds to a common exhaust gas duct in the service trench. Gases are drawn out of this duct by a blower, and forced out a 30-in. stack in an adjacent tower of the building. The exhaust line expansion joints were made by using piping of two sizes, placing the smaller inside the larger for a distance of about 6 in. and packing the annular space between the two pipes. Cooling of the exhaust gases by means of a water spray in the vertical pass of the burned gases not only cools the gases well below the ignition point of the packing, making lagging of the exhaust piping for operators' protection unnecessary, but also eliminates the possibility of continued combustion or explosion arising from over-rich combustible mixtures. This arrangement also materially reduces exhaust noises, and yet does not in any way interfere with the taking of gas samples or with the determination of actual flue gas temperature in the manifolds.

Air for starting is supplied from a high-pressure seamless steel tube reservoir some 25 ft. long suspended from the ceiling and directly over the engines. During test runs the reservoir is recharged by a small two-stage air compressor operated as an integral part of one of the diesel engines.

The gasoline engine testing station contains ten active engines of four-, six- and eight-cylinder designs, embracing truck, passenger car and airplane motors, and four spare engines mounted in frames in storage, ready for substitution during periodical inspection and repairing of the regular test engines, and available for student examination, disassembly and reassembly at other times. In planning this portion of the laboratory no discrimination was made against engines with transmissions. Instead a composite arrangement of both types is employed effectively.

The foundation for this station consists of a reinforced concrete slab, Fig. 4, roughly 28x20 ft. laid on top of the existing floor. Imbedded in this slab are five box rails on either side of the central longitudinal trench. The two rails adjacent to the trench are employed to support and secure the dynamometer, while the remaining rails on either side of the trench are used for securing the engine frames.

This construction not only makes available more space than would have been the case had the existing floor been used as the foundation, but it also permits the concealment of exhaust and water piping, and, in addition, with the floor drainage system thereby made possible, makes the maintenance of a clean, shipshape appearance comparatively easy.

The engines are supported by welded frames, fabricated of suitable channel and angle members, and are mounted on 5 ft. 4 in. centerlines on either side of the longitudinal service trench. Running from the outer edges of the platform to the central trench and under each engine centerline are sloped drainage lines to which floor drains are connected. The drains are placed between each set of rails, directly under the engines, and the floor is pitched between rails and between drains.

All water and exhaust piping runs laterally from the service trench through sheet-metal ducts in the concrete slab to points below the transmission ends of the engines. The remainder of the piping is above the floor and visible. Thus each engine has an individual exhaust line, concealed along the greater part of its length, directly connected to a common exhaust duct in the service trench; a variable temperature water supply line and two alternate hot-water returns, one of which may be used for weighing the cooling water, the other leading the water directly to waste.

For loading the engines a 150-hp., 2,200-3,500-r.p.m. Sprague dynamometer with full automatic field and ignition control is the standard, although provision is made through an auxiliary panel for testing eight additional engines simultaneously by means of water, Prony, rope or band brakes, without interfering in any way

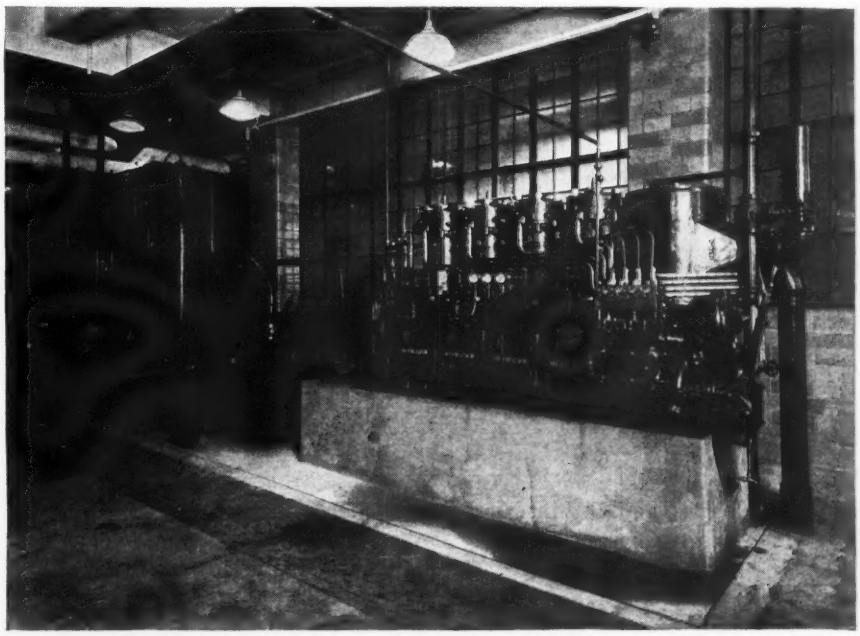


Fig. 2—Two solid-injection diesels are part of the equipment

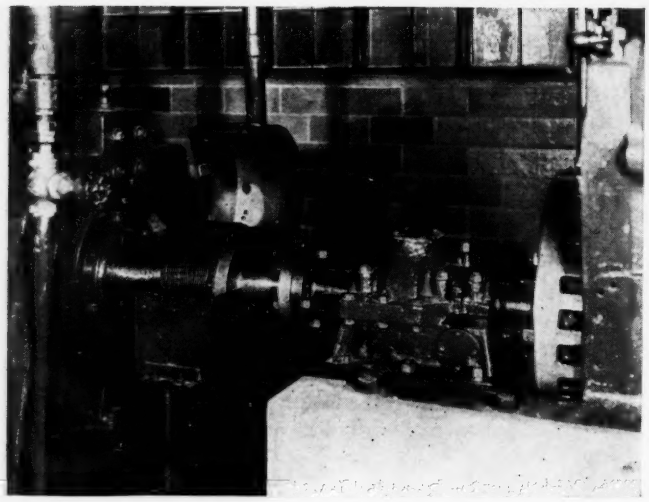


Fig. 3—Silent-chain coupling employed to connect a diesel engine to the dynamometer

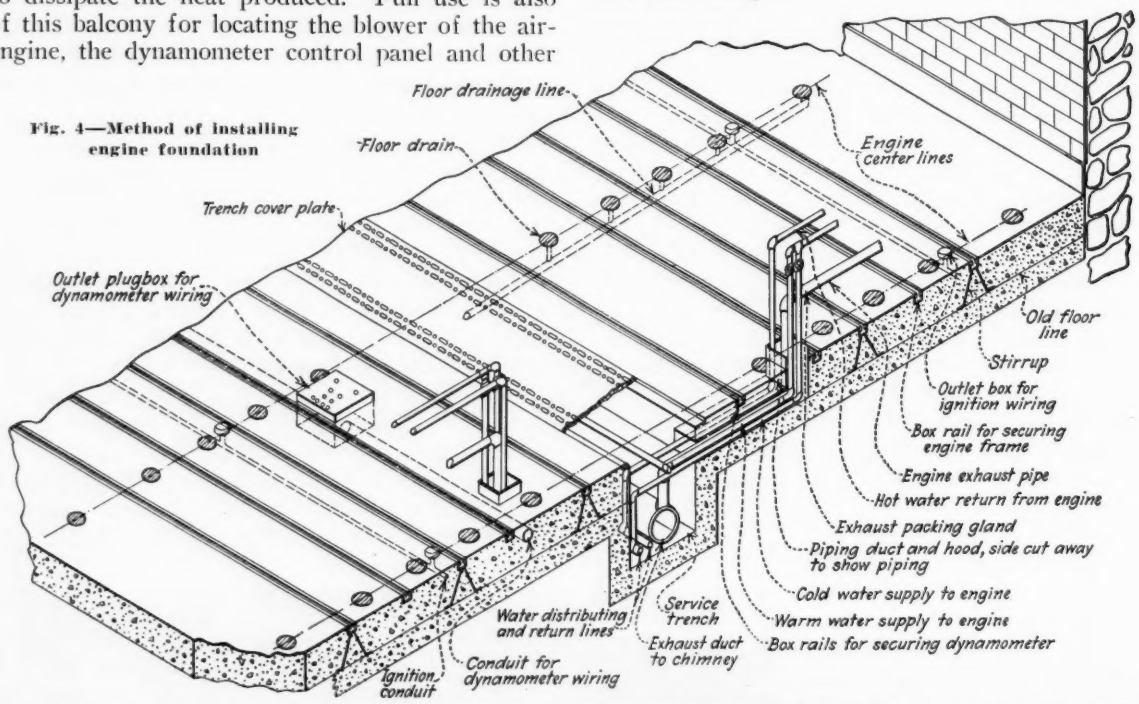
with the operation of the dynamometer-loaded engine. Air-cooled resistors placed on a small overhead balcony serve to dissipate the heat produced. Full use is also made of this balcony for locating the blower of the airplane engine, the dynamometer control panel and other auxiliary equipment. The master and supplementary ignition panels, however, are at working heights on the floor of the laboratory, immediately adjacent to the engines.

A noticeable feature of the electrical work is the absence of unsightly wiring, either overhead or on the laboratory floor. All such connections are carried through the foundation in suitable conduits, with all junction boxes and piping covered with a thin layer of concrete. Outlets are provided at the rear of the west bank of engines for making necessary armature, field and speed indicator connections through short insulated leads. When not in use these outlets are covered with galvanized hoods to keep out dust and water.

Connection of the gasoline engines to the dynamometer is made with a tension sleeve-type flexible coupling as shown in Fig. 5. Each end of the dynamometer shaft is permanently fitted with a standard half coupling carrying all the pin bushings. The mating half coupling is carried from engine to engine and is mounted on standardized stub shafts permanently connected either to the engine crankshaft if no transmission is used, or to the drive shaft if the engine is supplied with a transmission. Each stub shaft has two milled keyways. To prepare any engine for test it is only necessary to slide the tension sleeve backward along the engine stub shaft, enter the pins in the bushings of the mating half coupling on the dynamometer and tighten the sleeve with a pin wrench to prevent axial motion of the tension sleeve half coupling.

A three rail traveling crane is employed to convey the dynamometer from one test position to another. The two outside rails carry the main carriage and chain hoist which may be moved laterally as well as longitudinally, while the third, or middle, rail carries an auxiliary carriage which can be moved only longitudinally. The main carriage and hoist alone are employed to lift the engines at times of repair or replacement, while for transporting the dynamometer the two carriages are coupled through a distributing bar and the load is equally borne by all three rails. In this way a one-ton hoist is used in apparent defiance of the laws of physics to lift a three-ton load with safety.

Fig. 4—Method of installing engine foundation


Floor drainage line
Floor drain
Engine center lines
Trench cover plate
Outlet plugbox for dynamometer wiring
Old floor line
Stirrup
Outlet box for ignition wiring
Box rail for securing engine frame
Engine exhaust pipe
Hot water return from engine
Exhaust packing gland
Piping duct and hood, side cut away to show piping
Cold water supply to engine
Warm water supply to engine
Box rails for securing dynamometer
Service trench
Water distributing and return lines
Exhaust duct to chimney
Conduit for dynamometer wiring
Ignition conduit

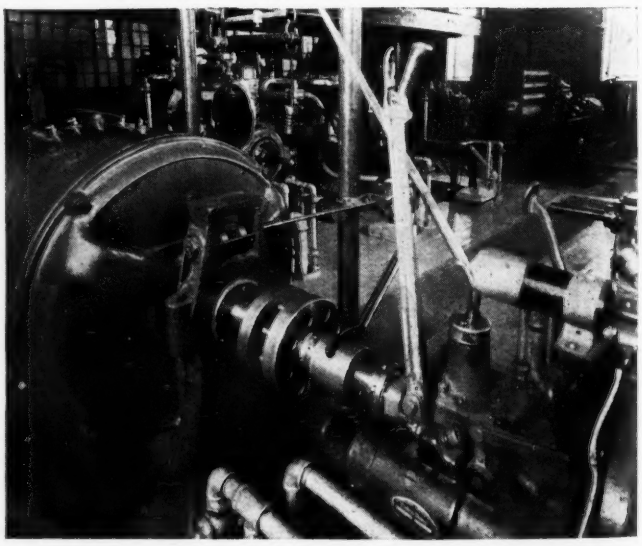


Fig. 5—Type of coupling used on the gasoline engines

PRACTICAL AIDS

TO OPERATION

Trouble With Sludging in Turbine Lubricating Oil

IN A CERTAIN PLANT a 2,000-kw. turbine had been operated about three years without any appreciable difficulty with the lubricating system. At regular intervals several gallons of oil were drawn off from the bottom of the reservoir and an equal amount of fresh oil added.

In due course a second 2,000-kw. turbine was installed, of the same make as the first but a machine of earlier design and one that had already seen ten years of service in another plant. At the same time, in order to reduce the rate of oil consumption to an even smaller figure than previously experienced, a centrifugal oil purifier was installed so that oil from either unit could be passed through the purifier continuously during regular operating periods, or in batches when the turbines were at rest.

Shortly after the second unit was placed in service evidences of an excessive accumulation of water in its oil reservoir appeared, and within a few months serious troubles began to develop. Oil grooves in the thrust bearings became clogged, and a thrust bearing burned out. The oil strainer frequently became clogged with sludge. Finally, after about six months, when the oil piping was dismantled for inspection, it was found that a soft light brown sludge had accumulated to such an extent that many of the smaller pipes were nearly closed and the bearings themselves showed signs of inadequate lubrication together with a coating of rusty sediment or sludge.

About the same time one of the governor oil relay pistons on No. 1 turbine stuck, causing it to trip out on overspeed. It then developed that the oil system on this unit also showed signs of abnormal sludging, but in this case the deposit consisted of a dark-colored, relatively hard, adherent scale. A survey was undertaken to uncover all possible contributing causes to the trouble and to devise a suitable remedy. A summary of the resulting conclusions as to possible sources of trouble follows:

1. As far as No. 1 turbine was concerned there were no conditions evident which would be expected to cause undue deterioration of the oil except that the oil temperature was slightly high.

2. On the No. 2 turbine there was excessive leakage of steam around the shaft at the high-pressure packing, and the location of the oil reservoir was such that much of this steam might enter the reservoir.

3. Due to high concentrations existing in the boilers, it was quite possible that the water reaching the oil reservoir might be contaminated with boiler-water salts. This condition could well have been aggravated by the fact that the trap on the steam separator just ahead of the turbine throttle had ceased to function because of an accumulation of bits of packing and sediment or scale in the pipe line leading to it.

4. Taking the path of least resistance, pipe fitters had connected the oil reservoir to the purifier by means of a line leading from an easily accessible existing tap rather than drill and tap for a new connection at the low point of the reservoir.

5. The capacity of the oil reservoir on No. 2 turbine was small (60 gal.) as compared with that of the No. 1 unit (150 gallons).

6. A laboratory study of the effect of water from various sources, on both new and purified oil, gave the results shown in the illustration, indicating that the presence of salts in the water might well have a marked effect on the tendency to sludge.

The water and oil were heated separately to 170 deg., mixed to give 10 per cent water by volume and agitated vigorously for 10 minutes. The samples shown were allowed to stand for over a week before being photographed.

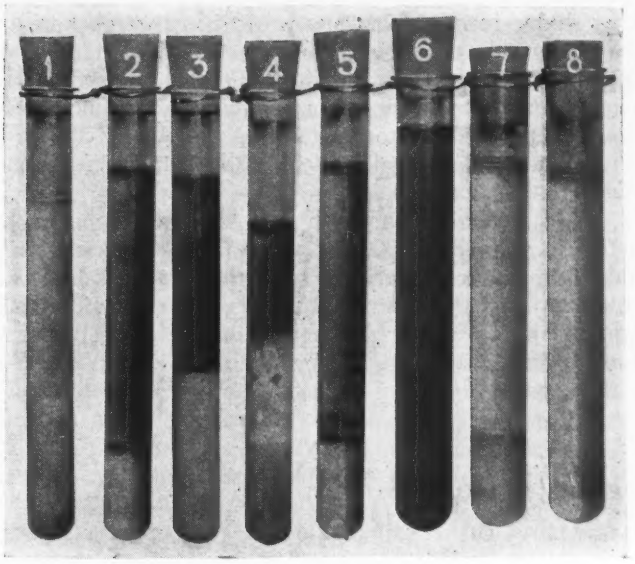
From the evidence accumulated in this brief study it was apparent that several conditions favorable to the formation of sludge existed, and immediate steps were taken to eliminate, or at least minimize, the effects of as many of them as possible. The boiler blowdown rate was increased, a more rigid schedule of steam trap inspections was set up, and the location of the oil purifier connection on No. 2 turbine reservoir was changed to take off at the lowest point. Initial efforts to reduce the leakage around the high-pressure seals on No. 2 turbine failed, but after several attempts a considerable improvement was effected at this point. From the results of the laboratory tests and from observation of the procedure followed by the operators when switching the

ANALYSIS OF SLUDGE, NO. 2 TURBINE, PER CENT

Water	27.0	
Mineral oil	33.5	
Insoluble in petroleum	39.5	100
Insoluble in chloroform	9	
Ash	6.5	
Hydrocarbons soluble in chloroform	30.5	
Iron oxide in ash	50	

OIL TEMPERATURES, DEG. F

	To Cooler	From Cooler
No. 1 turbine	172	154
No. 2 turbine	140	118



Samples of new and purified turbine oil

(1) New light oil mixed with water from oil purifier; (2) purified oil mixed with condensate from discharge of condensate pump; (3) purified oil mixed with water from the purifier when operated on No. 1 turbine; (4) purified oil and concentrated boiler water; (5) purified oil and water from purifier No. 2 turbine; (6) purified oil from No. 2 turbine; (7) new light oil and concentrated boiler water; (8) new light oil.

purifier from one turbine to the other, it seemed possible that sludge-forming elements present in that portion of No. 2 turbine oil, which was transferred each time to No. 1 turbine reservoir, might be the prime cause of the sludge formation on the latter machine. Accordingly, the common purified oil storage tank was eliminated and two entirely separate 50-gal. tanks substituted, one for each machine.

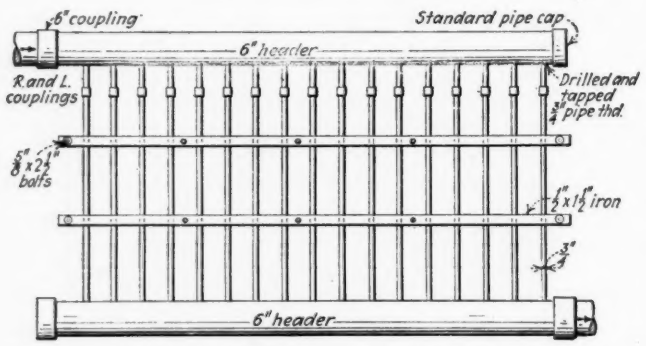
These various changes in procedure were put into effect in October, 1930, and though conditions are still far from perfect experience since that date has been so satisfactory that tentative proposals covering additional equipment for further protecting and purifying the turbine oil have been held in abeyance. A. S. WELLS.

Kingsport, Tenn.

Reducing Troubles From Ice Collecting on Trash Rack

IN MANY condensing steam plants in the North considerable difficulty is often experienced with the trash racks for condenser intake water. In very cold weather ice may form on the racks. Floating ice, leaves, and other refuse may collect on the racks, freezing in a solid mass, and removal will be difficult and dangerous to the worker. If the water level is low in the river or lake supplying the cooling water a drop in level of the water passing through the racks will result.

There are a number of ways of preventing this. A common one used, feeding warm water into the forebay, often increases the trouble by stirring up all the mud and refuse at the bottom. A system that will work satisfactorily and will not cause this trouble is shown



Details of trash rack of pipe construction

in the diagram. It consists of a horizontal 6-in. header at the top and bottom of the rack position.

These headers are drilled and tapped, at the same spacing as the former rack bars, and ¾-in. extra-heavy pipes are connected between them. These pipes take the place of the rack. Suitable bracing is given by a length of ½-in. strap iron bolted back and front of the pipes as shown. The lower header discharges at the downstream side of the plant to prevent undue agitation of the intake water. The upper header is supplied with waste water if available at a temperature of over 90 deg. If not it can be supplied with a pump drawing discharge water from the condenser. The temperature is raised to this point by throttling the circulating pump discharge, and little loss in vacuum should result. In some cases it may be found advisable to use low-pressure steam for this purpose. H. M. SPRING.

Milford, N. J.

CURRENT COMMENT

A.S.M.E. Collects Oil Engine Power Cost

INFORMATION collected by the American Society of Mechanical Engineers on oil engine power cost includes reliable and comprehensive data covering several years of oil engine operation. The initial report of the subcommittee having this work in charge, submitted in 1929, covered only 27 diesel plants containing 68 engines, and was devoted almost entirely to operating cost. The most recent report, submitted in 1931, lists 94 plants containing 283 engines and presents data on many phases of operation.

Early in its history the subcommittee found that it had to undertake considerably more than the soliciting and subsequent tabulating of data. Due to the lack of a uniform practice for the reporting of data, there was initially a great amount of overlapping and conflict between plants on operating cost catagories, and no general acceptance of definitions for determining such items as "peak load," "type of service," "liner wear," etc. Therefore, a number of standards have been set up from time to time and the latest questionnaire (covering 1931 power cost), which is now being mailed to operators of diesel stations, repeats definitions of the following: Type of service (that is, complete power, base load, peak load, stand-by, seasonal) net output; liner wear; peak load; attendance and superintendence cost; supply cost; miscellaneous cost; repair cost; type of cooling water system; and invested cost.

While the questionnaire is one that can be completely answered by an operator keeping only the best of records, a distinction is made between essential cost questions and those that are non-essential operational ones. No operator need feel ashamed of his inability to answer all of the minor questions—as a matter of fact, few operators can. Due to the fact, however, that no questions remain unanswered by everyone, much information is being collected on these points, which, while not essential for determining total production cost, is highly important from an operating standpoint.

The subcommittee's work has a threefold result. The first is that of education of operators. The increase in number of questions answered and in the precision of the answers testifies to this. The second phase is the information furnished on power cost, and it is quite revealing to find out how many engineers are keenly interested in this subject, many of them not present users of diesel power. In the third place the reports supply information on operation, such as data on fuel and lubrication economy, lubricating oil purification, cooling-water handling, liner wear and peak loads handled. These matters are of great interest to operators, accessory manufacturers, fuel and lubricating oil engineers, engine designers and consulting engineers generally.

Of course, the full value of these investigations has not yet been reached, nor will it be developed for some

years. Power-cost figures will take on more authority with a wider representation of plants and a long succession of years. Various relationships between operating conditions await more data before they can be conclusively demonstrated and evaluated. At some time in the future it is expected that the data will show the effect of carbon and ash in fuel oil, results to be expected from air filtering, best method of lubricating oil purification, life of liners, length of the repair-cost cycle, useful life of engines, proper attendance ratio and proper rating for various types of engines.

The subcommittee has no bias in the matter of selection of plants for listing. The only requirement is that data be sufficient to allow the calculation of power cost. Although the mailing list is being increased from time to time, no doubt there are many that are not receiving questionnaires. Any operator of an oil engine plant that generates electric power is eligible, and requests for the questionnaire forms are always welcome. Names of operating companies and makes of engines are held in strictest confidence by the subcommittee. All contributors are supplied with advance copies of the reports after these are collected.

The progressive growth of this research program can be gaged by the fact that the first report of the subcommittee was greeted with more or less apathy, the second with considerable interest, while the supply of advance copies of the third report is long since exhausted although several times as many copies were printed as for the previous year. The subcommittee is confident that the report to be submitted late this Spring covering data for 1931 operation will be even more extensive and valuable than the last. Each operator who receives a questionnaire should make every effort to fill it in and return it. Any operators who do not receive questionnaires by Feb. 15 should immediately get in touch with the subcommittee by addressing it at 29 West 39th St., New York City.

M. J. REED, *Secretary,*
A.S.M.E. Subcommittee on
Oil Engine Power Cost.

New York City.

Saving Possible With Dual Pump Drive

AN ARTICLE by H. M. Spring entitled "Saving Possible With Dual Drive" appeared in *Power* for Dec. 22, 1931. Mr. Spring assumes conditions in an industrial plant where one boiler supplies steam to a turbine-generator having a power load of 650 kva. throughout the day with a 350-kw. lighting load added after dark. If the boiler is of sufficient size to carry the maximum load economically, then during the day, while on part load, the boiler is operating at a decreased economy. Partly to correct this condition, Mr. Spring proposes a centrifugal boiler feed pump with turbine on one end and a motor on the other end. During the light-load period the pump would be turbine-driven, but when the power load increased to around 88 per cent of maximum, automatic control would cut in the motor and cut off the turbine. Mr. Spring claims this would reduce the maximum load on the boiler, as the additional steam taken by the main turbine-generator to supply the motor load would be considerably less than the amount of steam required by the small non-condensing turbine driving the pump.

It is true that the small non-condensing turbine will take more steam, possibly three times as much as the large turbine, which is assumed as operating condensing. Mr. Spring does not, however, give consideration to the fact that the latent heat in the exhaust steam from the small turbine, if recovered in a feed-water heater, would return to the boiler much more energy than this difference in steam consumption. The fact that the plant is assumed as having electrically driven auxiliaries would indicate that the exhaust steam could be used to advantage. There may be some other economical means, not mentioned by Mr. Spring, of heating feed water, in which case it would be more economical to operate the motor drive normally at all loads.

In a plant where there would be an excess of exhaust steam for certain periods, and a lack of it at other times, a dual-drive pump could be used to approach a condition of heat balance. The control apparatus should then be thermostatically actuated by the feed-water temperature, causing the turbine to operate at the lower feed-water temperatures, and the motor to assume the load at other times.

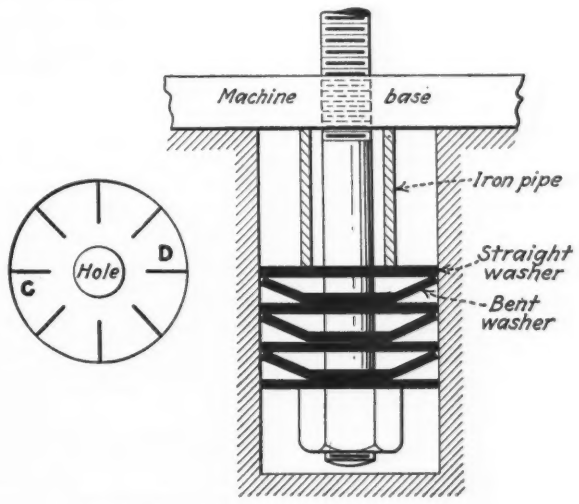
T. F. FOLTZ.

Washington, D. C.

Gripping Foundation Bolts for Heavy Machines

WITH REFERENCE to the letter of J. T. Towlson on "Gripping Foundation Bolts for Heavy Machines," which appeared some time ago, the accompanying sketch shows what in my opinion is a much better design.

The washers used to do the gripping are the ordinary iron washers $\frac{1}{8}$ in. thick and about $\frac{1}{4}$ to $\frac{3}{8}$ in. larger than the diameter of the foundation bolt hole. Cuts are



Holding washers designed to wedge in foundation bolt hole

made in each washer as indicated. The slotted washer is then clamped between two nuts or between the jaws of a bench vise and each section, as *C, D,* around the washer is bent to form a cup washer.

The cup washers, and straight washers slightly smaller in diameter, are assembled as shown. The assembly is placed in position, and by means of a piece of iron pipe the washers are sprung sufficiently to grip the concrete. Hard steel washers cannot be used, as the bending and straightening process would tend to break them.

Toronto, Ont. JAMES E. NOBLE.

READERS' PROBLEMS

OILING A SUBMERGED BEARING—*We are troubled with the oiling of two conveyor shaft bearings which are submerged under water. The grease we use seems to wash away. Is there any special grease for such conditions?*

D.MCF.

Greases generally are composed of a mineral oil product, animal fat or soap, and, in some cases, talc to give the grease more body. If the soap is of a lime base the grease will be insoluble in water, but if of a soda base the water reacts with it and dissolves and the lubrication is ineffective. Most lubrication companies have special insoluble greases for such applications.

At present it is possible to obtain bearings made of rubber compound which need no lubrication other than the water. If the water is heavily saturated with grit it may be necessary to run clear-water lines to the rubber bearings. In addition special copper-graphite non-oiling bearings are available.

COMPARATIVE AMOUNT OF STEAM AND AIR REQUIRED FOR PUMPING—*What is the relative cost of air and steam used for pumping water with a 12x8x13-in. duplex steam pump?*

C.O.R.

Not knowing the pressure or head against which the water must be pumped, no accurate answer can be given, but the method of approach will be outlined.

Let it be assumed that the pump is to handle 100 gal. per minute against 200-ft. head. The water horsepower = $\frac{WH}{33{,}000} = \frac{100 \times 8.33 \times 200}{33{,}000} = 5+$.

A 12x8x13-in. duplex pump will use about 100 lb. of steam per indicated hosepower-hour. The mechanical efficiency is about 75 per cent. This will make the steam consumption per minute $\frac{5 \times 100}{0.75 \times 60} = 11+$ lb., the amount required to lift 100 gal. 200 ft., assuming the 200 ft. to cover the vertical left, the friction and the slight velocity head.

In the table can be found the necessary air pressure and the cubic feet of free air needed to lift one gallon of water. Since the steam cylinder has a diameter of 1½ that of the water cylinder, from the table it is found that to lift 1 gal. 200 ft. will require 1.53 cu.ft. of free air and the air pressure must be 48.8 lb. For 100 gal. the free air will amount to 153 cu.ft.; this when compressed to 48.8 lb. will have a volume of

$$\frac{14.7}{(48.8 + 14.7)} \times 153 = 35.4 \text{ cubic feet.}$$

The water volume is $\frac{100}{7.48} = 13.3 +$ cu.ft., and as the air cylinder is 1½ the diameter of the water cylinder, the air volume would be $(1.5)^2 = 2.25$ times the water volume, or $2.25 \times 13.3 = 29.9$ cu.ft. The difference, 35.4 — 29.9 = 5.5 cu.ft., is the air filling the clearance space. To compress a cubic foot of air per minute to 50 lb., assuming that some heat is lost during compression, will require about 0.11 hp. The 153 cu.ft. will then require 16.8 horsepower.

Compared on an hourly basis, the output of 200 gal. per minute will require 16.8 hp.-hr. with air and with steam would need $11 \times 60 = 660$ lb. of steam. The relative costs would depend upon the cost of steam and the cost of compressing the air. Assuming an 85 per cent efficiency of the motor and compressor, with power costing 3c. a horsepower-hour and steam at 40c. a 1,000, the ratio of air to steam costs would be $\left(\frac{16.83 \times 3}{0.85}\right)$ to $\left(\frac{40 \times 660}{1{,}000}\right)$ or 2.26 to 1.

OIL GROOVES IN BEARINGS—*Our steam engine bearings are provided with oil grooves in the form of an X, located in the bottom shell. The oil is introduced at a pressure of 10 lb. through the top of the bearing. It is necessary to replace the babbitted shells. Our problem is, is there any reason for the oil grooves?*

Theoretically, if there is a complete oil film maintained there should be no excuse for the groove, but when the engine is first started up the journal may be dry, or at best the oil film may be incomplete. The grooves then serve as a reservoir out of which oil may be drawn by the rotating shaft. After the oil flow from the pump is well established the groove has no duty. On the other hand, as long as there is pressure upon the oil feed the grooving will not interfere with the oil film.

FUEL OIL FOR BUILDING HEATING—*Is the use of fuel oil for building heating purposes increasing?*

C.D.

Data on 1931 are not available, but comparing 1930 with previous years it will be found that oil burning has not increased in commercial building but has increased for domestic heating.

The heating of buildings, both domestic and commercial, required 27,165,793 bbl. of gas oil and fuel oil in 1930, compared with 24,977,398 bbl. in 1929; 22,398,661 bbl. in 1928; 20,984,251 bbl. in 1927; and 16,779,582 bbl. in 1926. The heating of commercial buildings, such as offices, apartments, schools, hotels and hospitals, called for 17,343,590 bbl. in 1930, a slight decrease from the 17,819,607 bbl. delivered under this classification in 1929. The corresponding figures for previous years are 16,427,105 bbl. in 1928; 15,750,506 bbl. in 1927; and 13,874,181 bbl. in 1926.

The net loss in deliveries of commercial heating oils in 1930 is attributable to a drop of 21.9 per cent in demand in the Pacific Coast area, where a wider use of natural gas in 1930 has been a factor. Furthermore, a minor decline of 2.2 per cent is also indicated for the New England States,

Perpendicular Height in Feet to which the Water is to be Pumped	Ratio of Diameter of Air Cylinder (the Steam Cylinder) and Water Cylinder											
	1 to 1		1½ to 1		1¾ to 1		2 to 1		2¼ to 1		2¾ to 1	
	Air Pressure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water	Air Pressure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water	Air Pressure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water	Air Pressure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water	Air Pressure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water	PrAir essure at Pump Lbs.	Cu. Ft. Free Air per Gal. of Water
25	13.75	0.21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
50	27.5	0.45	18.22	0.65	.....	.....	.....	.....	.....	.....	.....	.....
75	41.25	0.60	18.33	0.80	13.75	0.94	.....	.....	.....	.....	.....	.....
100	55.0	0.75	24.44	0.95	19.8	1.14	13.75	1.23	.....	.....	.....	.....
125	68.25	0.89	30.33	1.09	22.8	1.24	17.19	1.37	13.75	1.53	.....	.....
150	82 5	1.04	36.66	1.24	27.5	1.30	20.63	1.52	16.5	1.68	13.2	1.79
175	96.25	1.20	42.78	1.39	32.1	1.54	24.06	1.66	19.25	1.83	15.4	1.98
200	110.0	1.34	48.88	1.53	36.66	1.69	27.5	1.81	22.0	1.97	17.6	2.06
225	.....	.....	55.0	1.68	41.25	1.84	30.94	1.96	24.75	2.12	19.8	2.10
250	.....	.....	61.11	1.83	45.83	1.90	34.38	2.11	27.5	2.26	22.0	2.34
300	.....	.....	73.32	2.12	55.0	2.39	41.25	2.40	33.0	2.56	26.4	2.62
350	.....	.....	85.4	2.41	64.16	2.59	48.13	2.69	38.5	2.85	30.8	2.88
400	.....	.....	97.66	2.70	73.33	2.88	55.0	2.98	44.0	3.15	35.2	3.18
450	.....	.....	.....	.....	82.5	3.19	61.88	3.28	49.5	3.44	39.6	3.36
500	.....	.....	.....	.....	.....	.....	68.75	3.37	55.0	3.73	44.0	3.53

Pressure and volume of air for pumping with duplex steam pump

while all other sections of the country showed a gain.

Domestic heating, in 1930, continued to show an increase as in former years. The totals reported were 9,822,203 bbl. in 1930; 7,157,791 bbl. in 1929; 5,971,556 bbl. in 1928; 5,233,745 bbl. in 1927; and 2,905,401 bbl. in 1926. The domestic heating figures given do not include furnace oils and light distillates. Estimates based on reports submitted by refiners to the Bureau of Mines indicate that, in addition to fuel oil and gas oil used in domestic heating, 15,537,000 bbl. of lighter oils was sold for this purpose in 1930, compared with 12,423,000 bbl. in 1929 and 8,300,000 bbl. in 1928.

Including all grades of oil, the heating of buildings in 1930 required 42,702,793 bbl. against 37,400,398 bbl. in 1929; and 30,698,661 bbl. in 1928.

▼ ▼ ▼

Operating a Steam Engine Without Cylinder Lubrication

Summary of Readers' Opinions on the Previous Question

IS IT TRUE that vertical steam engines can be operated without cylinder lubrication when superheated steam is employed? E.N.R.

IN ANSWERING this question, readers varied as to the limitations to be set up in considering the problem. Basing his opinion on his experience in the Navy, Frank R. Walker, Ensign, U.S.N. (retired), Cincinnati, Ohio, writes that during the seven years' experience he had in the marine service it was the practice not to use internal lubrication for reciprocating machinery. The large four-cylinder triple-expansion vertical engines used on the battleships some fifteen years ago were operated at 300 lb. gage and 100 deg. F. superheat without internal lubrication. The rods were swabbed at infrequent intervals with cylinder oil. If the engines were going to be out of service for three weeks or more the heads of the cylinders were removed and the walls coated with vaseline. Unless the engines were being worked on, they were turned over every day with the jacking gear. These engines had piston valves fitted with solid-type rings. The cylinders were steam-jacketed.

On the auxiliary machinery, when the valves and rings were new, or perhaps a cut taken off a seat or valve in order to true up a rough surface, a moderate amount of cylinder oil and graphite would be introduced until the surfaces had worn smooth. After a few hours service they would be operated without internal lubrication except an occasional swabbing of the piston rod with cylinder oil.

HIS OPINION has the concurrence of J. C. Nutter, Quebec City, Can., who says he has seen a 450-hp. vertical engine operate without cylinder lubrication. He also cites the non-lubricated piston valve of a Westinghouse-Parsons steam turbine, oscillating at 138.5 times a minute, lifting the primary valve in varying amounts, depending on the governor, for which the Westinghouse service engineers recommended "dry operation."

The engine mentioned was a double-expansion, vertical unit and operated at 360 r.p.m. The cylinder walls had a shine that would please any operating engineer. It is standard marine practice, Mr. Nutter states, to operate all vertical engines without cylinder lubrication, for two reasons: Lubrication is not necessary, and it would be most difficult to remove all the oil from the condensate, which is re-used.

It seems that cast-iron rubbing on cast-iron receives its lubrication from the graphite particles dispersed throughout the casting, some of which are exposed at the surface. For this reason a steel piston working in a steel cylinder would not work, neither would there be any success if the castings were of white or chilled cast iron. The presence of graphite is essential.

SHARP ISSUE to such claims is taken by K. A. Newman, Philadelphia, Pa., who is emphatic in the statement that it is not true that vertical steam engines can be operated efficiently and economically without cylinder lubrication when using superheated steam.

He concedes that it was common practice a few years ago to supply sufficient lubrication to marine engine cylinders by means of swabbing the piston rod with waste soaked in oil. This lubricated the gland and some operators claimed that a small amount of oil was so transferred to the cylinder walls.

With the low steam pressures of yesterday, due to cylinder condensation and the entry of water with the steam in the cylinders water was present in such quantities as to perform the functions of a lubricant and, in fact, the rings rode on a film of water. Steam pressures being low, the water was able to provide a good enough piston seal which prevented blow-by.

Today, Mr. Newman continues, the whole problem has changed, for steam pressures and temperatures have increased, requiring a careful choice of and application of oil to the cylinders.

High steam temperatures in the modern installation mean dry or practically dry cylinder walls. High steam pressure means that there will be large unit pressures exerted on the cylinder walls by the piston rings, caused by steam's entering the ring slots and forcing the rings to bear hard on the walls.

Therefore, to reduce wear a cylinder lubricant must be used. True. Mr. Newman concedes, we do not have to contend with the weight of the piston in vertical engines, but we canont get away from ring pressures no matter in what plane we place the engine.

A SIMILAR STAND is taken by A. W. Thorson, Detroit, Mich., who explains that the reason certain vertical marine engines are supplied with no cylinder lubrication is that moisture in the saturated steam prevents excessive wear. In this service proper lubrication was sacrificed to obtain oil-free condensate for boiler-feed water.

The first users of superheated steam in engines believed it necessary to use the most viscous, high-flash mineral oil obtainable so that it would not evaporate from the cylinder walls before proper lubrication had been provided. This oil, however, did not atomize in the body of the steam and pools of it accumulated, carbonized and scored valves and cylinders .

Obviously, no specific selection of lubricants can be made without detailed information regarding each application. However, the use of 200 deg. F. superheat indicates a pure mineral oil of high viscosity consistent with good atomization in the steam. When the superheat is much below 200 deg. F. moisture will probably appear in the exhaust and the conditions affecting lubrication are similar to those which exist when using saturated steam. The high superheat oil is not suitable in this case, Mr. Thorson believes, unless a compound is added to provide protection during the exhaust stroke. A medium-viscosity oil should be selected that will atomize readily and contain from 2 to 5 per cent of tallow oil or other compound. The compound lowers the viscosity, improves the atomizing qualities and forms an emulsion with the moisture.

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A Question for Our Readers

OUR THREE 6,000-sq.ft. boilers are equipped with underfeed stokers. At present we are burning run-of-mine having a fusion temperature of over 2,200 deg. F., but are offered slack having a fusing temperature of below 1,900 deg. F. at a reduction of $2 a ton. The heat value is but slightly less than that of the run-of-mine. Will the stokers handle the coal? C.J.K.

Suitable answers from readers, if received promptly, will be paid for when published.

Protective Devices Discussed At A.I.E.E. Convention

A description of a new type of high-speed distance relay for protection against line-to-line faults on short lines; practical applications of the oil-blast principle to high-voltage circuit interruption; and recent development in arc-rupturing devices were features of the meeting on circuit protective devices. An abstract from President C. E. Skinner's address, "The Engineer as a Citizen" is included

WITH a technical program that included 65 papers, the American Institute of Electrical Engineers held one of its most successful winter conventions at the Engineering Societies Building, New York City, Jan. 25 to 29. The fourteen technical sessions were scheduled to meet the needs of a large proportion of the membership, being broad in scope and of current interest. Four of the sessions comprised important symposiums on distribution-circuit lightning protection; auxiliary drives for power-station; the system stability; and time and time service.

The Engineer as a Citizen

President C. E. Skinner opened the convention with an address, "The Engineer as a Citizen," in which he said, in part, that the institute has a most enviable opportunity, supplying, as it does, the forum for the announcement of new discoveries, the records of achievement from year to year, and for discussion of the problems which the industry must face and solve. The members of the institute, together with members of the engineering profession, may take great pride in the measures taken by the profession for the relief of the unemployed during this trying time of lowered industrial production, he said.

"Through our local sections," Mr. Skinner continued, "the cooperation of the groups being organized through the American Engineering Council and Committee on Unemployment, engineers as a group have probably done more for the relief of their fellow members than any other group or profession. Through our participation in the American Engineering Council we have joined in the organization of special committees in almost every state of the union, and this action will do much to bring about greater solidarity in the engineering profession as a whole, even when this difficult time has passed.

"Our participation in the general work of the American Engineering Council and our joining with the plan of organizing state councils is bringing to us a greater appreciation of our responsibility, not only as engineers, but as citizens. In times such as these, when every sort of scheme, sensible and fantastic, is before the national congress, legislatures of the states, and even local governments, the calm, considered judgment of the thinking citizen is required as never before. At this time there is before the Congress of the United States more than 12,000 bills calling for appropriations totalling about 30 billion dollars, many of them with engineering content. Another 12,000 bills are expected to be introduced before the session is over. As engineers and as citizens it is our duty as well as our privilege to take such part as we may through the American Engineering Council and state councils, and by any other legitimate means, in giving advice as to which of these proposals are sound and which are not from an engineering point of view.

"We have heard much during the last year or two in regard to the part our so-called machine age has played in bringing about this period of depression and unemployment. The changes that have brought about mass production through standardization and the application of power-driven machines are inevitable and will continue. These things have been going on ever since the first application of power to replace handicraft, almost at the beginning of the last century. What is necessary above everything else in connection with such changes is that we adjust ourselves to them and that there be as little disturbance as possible to those elements which are of necessity affected or displaced.

"Our relatively high living standard should not only be maintained but increased and extended to all who do their part in production and distribution. We should endeavor so to adjust our laws and regulations that new and competitive devices of merit are on an equitable basis with those which have preceded them. The engineer above all should stand for fair dealing based on deductions brought about through fact finding. It is the engineer above all others who by training and experience is in the best position to arrive at correct conclusions in connection with many of the problems with which we are faced."

High-Speed Distance Relay

The opening technical session on Monday afternoon was devoted to protective devices at which five papers were presented. The first paper on the program, by S. L. Goldsborough and W. A. Lewis, described a new type of high-speed distance relay for protection against line-to-line faults on short transmission lines. The outstanding feature of this relay is that it is essentially unaffected by the presence of accidental fault resistance, but does not require the use of an auxiliary element to prevent operation of the relay under load conditions when there is no fault on the system.

Although the last two or three years have seen rapid advance in oil circuit breaker design, the theory of interrupting an alternating-current arc under oil is still a highly controversial subject. There are at least two schools of thought on the mechanics of arc interruption in oil and successful oil circuit breakers have been designed embodying each of these principles. One of these is known as the oil-blast theory and the other is that the arc is interrupted by deionizing the gases formed by the arc.

Oil-Blast Theory

The essence of the oil-blast theory is that arc interruption is brought about by interposing between the circuit breaker electrodes a wall of solid oil which grows at such a rate as to be always more than sufficient to resist puncture by the recovering voltage across the circuit breaker terminals. This growing barrier of oil sweeps before it the arc products so that phenomena of deionization occurring in the gases enveloping the arc do not influence the extinction phenomena. An analysis of this theory was given in a paper by D. C. Prince and data were presented to show the effect of time and carbon on oil dielectric strength, correlation between voltage recovery

rate and required oil velocity, lack of correlation between either current and voltage and necessary oil velocity, correlation between recovery rate and pressure in the explosion chambers.

From this study the opinion was drawn that in the case of impulse breakers the exact quantitative results obtained by measuring the oil dielectric strength under impulse conditions and the operation of the breaker under known oil velocity and recovery rate conditions prove beyond question that this breaker operates on the oil-blast theory as enunciated and in no other way. All of the factors discovered in connection with the other types of circuit breakers appear to confirm the same law; that is, variations tending to promote oil-blast action improve performance.

Oil-Blast Circuit Breakers

"Practical Applications of the Oil-Blast Principle of Circuit Interruption" was the title of a paper by R. M. Spurck, in which it was brought out that the oil-blast principle of circuit interruption has been applied to oil circuit breakers for high and low voltages and small and large interrupting ratings. Parts can also be supplied to apply this principle to many types of breakers already in service.

Breakers equipped with oil-blast show consistently short arc lengths and unusually short periods of arc duration, even at the higher rates of recovery voltage rise and over wide ranges of current interrupted. The result is that contact burning and oil deterioration are so minimized that the maintenance required is greatly reduced.

In many types of breakers to which oil-blast has been applied it has been possible to increase the interrupting rating of the structure. Many types of breakers already in service may be modified to incorporate the oil-blast feature and obtain high-speed operation. Also, in the newer designs the interrupting capacity per unit volumes is much greater than that previously obtained.

The rapid arc-extinction characteristic of the oil-blast design makes it adaptable to breakers requiring high speed of operation. Such high speed improves system stability, minimizes system voltage dips, and improves service in many other ways.

A.-C. Arc Extinction in Turbulent Gases

The effectiveness of gas blast in aiding alternating-current arc extinction is an established experimental fact. Even though a number of theories have been suggested, there has been presented little conclusive evidence to indicate the actual mechanism of their action. In a paper, "Extinction of Alternating-Current Arc in Turbulent Gases," T. E. Browne, Jr., described some recent experiments that have been and are being made in an effort to obtain such information. The results of these experiments reveal:

1. That, in general, the interrupting ability of an alternating-current arc is greatly improved by turbulent motion of the arc gases, this improvement increasing, in a fast circuit, almost in direct proportion to the gas velocity from which the turbulence results.

2. That the interrupting ability of a turbulent alternating-current arc depends very largely upon the composition of the arc gases, most gases being decidedly superior to air in this respect.

3. That the recovery of dielectric strength following a current zero by an alternating-current arc subjected to turbulence takes place in two consecutive phases, the first consisting of a very rapid recovery to a substantial value in a few microseconds, and the second of a much slower further recovery for a much longer period.

4. That at least one practical gas-blast circuit interrupter, the expulsion fuse, exhibits a volt-time interruption characteristic which clearly indicates the rôle of gas turbulence in its operation.

Deion-Grid Circuit Breaker

In the class of circuit breakers for automatic reclosing service on distribution feeder circuits there is a growing demand for breakers which may be subjected to repeat cycles of interrupting duty without requiring maintenance. These breakers are also required to reclose after clearing a short circuit with a much smaller time interval than the two minutes provided for in the present standard-duty cycle. The excellent characteristics of moderate-capacity deion-grid circuit breakers designed for this type of service have been demonstrated by many series of tests, according to R. C. Van Sickle and W. M. Leeds in their paper, "Recent Developments in Arc-Rupturing Devices."

A 15-kv. oil circuit breaker equipped with deion grids was subjected to a series of 21 short circuits of approximately 14,000 amp. at 3,810 volts, the duty cycle consisting of one CO plus two OCO tests at zero and 120-sec. intervals. The complete series of tests occupied only 45 min., during which time the tanks were not lowered for inspection of the contacts. The interrupted current varied from 12,200 to 15,300 amp., while the breaker closed against current from 15,000 amp. to as high as 28,800 amp. during the OCO tests. On one test an average of between 1.0 and 1.5 cycles of arcing occurred on a frequency of 60 cycles per second. This indicates a breaker time from the instant the trip coil was energized until the arc was extinguished of about six cycles.

The breaker performed satisfactorily during these tests. No appreciable drop in oil level was observed, the oil loss being limited to a few drops which seeped out between the operating shaft and bushing. Pressure records were obtained on several of the tests, but the values were only about 15 lb. per square inch. Considering the severe service applied to the breaker, the oil depreciation was moderate, the dielectric strength changing from an average value of 25.8 kv. before the tests to 11.4 kv. after the 21st test. When the contacts were examined at the conclusion of the tests they were found to be in condition for further service without maintenance.

Tests on Circuit Breakers.

Results of tests on breaker before and after the installation of deion grids were also given. On one of the large 44-kv. systems the interrupting duty imposed upon the breakers in a certain location was so heavy that a single operation was sufficient to blacken the oil. Gas and oil were usually thrown from the breaker and the arc was cleared only by utilizing practically the full contact-break distance.

The old-style contacts in one of these breakers were replaced by deion grids and the breaker subjected to a series of interrupting tests during which there was no throwing of oil and no sign of distress. The last five tests were made on one pole of the breaker, and the oil tested almost as high after the tests as before.

A smaller circuit breaker rated 350,000 kva. at 37 kv. was equipped with deion grids and its performance determined by a series of field tests on one of the largest 26.4-kv. systems. The breaker was first subjected to a two-OCO duty cycle at approximately 12,000 amp., followed after a short interval by one OCO test of approximately 16,000 amp. This last test imposed an interrupting duty of 750,000 kva. on the breaker, which was more than twice its rating with the old-style contacts. Although this was rather heavy service for a breaker with 20-in. diameter tanks, there was no external disturbance on any of the tests other than a small discharge of gas from the vent. The oscillograms showed only one cycle of arcing. After the three interruptions the oil was in good condition, having depreciated from 28 kv. to an average value for the three tanks of between 23 and 24 kv. The contacts when examined showed a negligible amount of burning, and further testing was prevented only by trouble with other apparatus involved in the test set-up.

Circuit-Breaker Discussion

The discussion on the circuit breaker papers was largely in defense of the two theories of arc interruption in oil. It was evident that the two schools of thought on this phenomenon are far from agreeing on the mechanics of arc interruption under oil.

Reports from operating companies called attention to improved service from breakers designed on the new principles over the older types. Objections were raised to the old duty-cycle ratings for the new types of oil breakers, and it was proposed that the time had arrived for a new standard duty cycle based on improvements made in design and experience gained with new breakers. It was suggested that more thought should be given to the performance of breakers when closing against short circuits. A device that

may operate favorably when opening the circuit may be objectionable on the closing stroke against a short circuit.

Great improvements have been made in circuit-interrupting equipments, and they can be had at the cost of the older and less effective devices. These improvements can also be applied to the old designs of breakers and greatly increase their capacity at a comparatively small cost, it was pointed out.

An outstanding feature of the convention was a symposium on steam-turbine electrically driven auxiliaries in steam plants. Abstracts of the papers and discussion forming this symposium are published beginning on page 195.

Electric-Arc Welding

The field of arc welding has been notable for the amount of original research carried on, as well as for the development and application of welding processes. An excellent example of scientific research applied to welding problems was presented by F. Creedy, of Lehigh University. Using the methods of the physicist, with elaborate equipment designed to measure delicate forces, Professor Creedy was able to explain an interesting and important phenomenon of the iron arc. It has been observed that when welding an overhead plate with an iron electrode globules of substantial size are detached from the rod at regular intervals and thrown up to the plate against the action of gravity. Professor Creedy showed that this is an electromagnetic effect, and computed the magnitude of the forces involved.

An improved alternating-current arc welder was described by A. M. Candy, who pointed to the disadvantages which have held back the application of the alternating-current welding machine in comparison with the more expensive direct-current machine. Among these are the following: (1) the open-circuit voltage of an alternating-current welder is about double that of a direct-current welder, thereby increasing life hazard; (2) an alternating-current arc is much more difficult to strike and hold, especially with bare welding wire, and for vertical and overhead welding; (3) low power factor.

These disadvantages are overcome by the machine described according to Mr. Candy, who said that its open-circuit voltage is as low or lower than that of a direct current machine, that the arc is as easy to start and hold in any position, under normal conditions, and the power factor is above that of a commercial induction motor used to drive a correspondingly rated direct current welding generator. These results are obtained by the use of a special oscillator circuit consisting of a small standard transformer, a condenser across the high side, or secondary, two spark gaps, and an iron-core choke coil. According to Mr. Candy, the welds made with this improved alternating current welder are in every respect equal to direct current welds.

Another paper, by K. L. Hansen discussed recent developments in the design of arc-welding generators. The aim and result of the work described, he said, was to produce a direct-current generator containing within itself all of the characteristics required for arc welding, thus eliminating the need for external stabilizing devices.

▼ ▼ ▼

A.S.H.V.E. and A.S.R.E. Meet in Cleveland; Exposition and Joint Sessions Held

THE annual meeting of the American Society of Heating and Ventilating Engineers was held Jan. 25 to 29 in Cleveland, with headquarters at the Statler Hotel. In conjunction with its meeting the society also sponsored the second exposition of heating and ventilating equipment. The first exposition of this nature was held in Philadelphia during the Society's annual meeting in 1930. The American Society of Refrigerating Engineers also held its annual meeting in Cleveland during the same week, two joint sessions having been arranged.

At the first two technical sessions of the Heating and Ventilating Engineers heat transfer was the general subject, treated in five papers. These papers discussed the effect of wind direction on surface coefficients, conductivity of concrete, transmission of radiant energy through glass, heat transfer through air spaces and heat emission from iron pipe.

Two important facts were disclosed in the paper by F. C. Houghten and C. Gutberlet on "Conductivity of Concrete." The coefficients generally available for concrete are too low, an average value of 12 B.t.u. per hour per square foot per degree F. being recommended. It was also shown that the conductivity of the concrete tested decreased continuously over a period of three years.

Considerable discussion developed on the reason for the changing conductivity, several engineers indicating they had similar experience and had obtained similar values.

The importance of radiation in heat transfer across air spaces was brought out in a paper by E. R. Queer, which reported tests made at State College, Pa. The author developed equations for determining heat transfer through air spaces and also concluded that plain bright metallic surfaces form an excellent heat insulation by reducing the radiant heat transfer. The optimum spacing for a single air space is 0.75 in. and increasing the height of a thin air space up to 35 in. increases the resistance to heat flow. In the discussion it was reported that three layers of aluminum foil per inch of air space would yield a conductivity of 0.31 to 0.34 B.t.u. per hour per square foot per degree at a temperature of 107 degrees.

A paper of interest to power as well as heating engineers, presented in the second session, was that by R. E. Hall and A. R. Mumford on "Fundamental Considerations of Corrosion in Steam and Condensate Lines," which gave the results of an extensive investigation into the factors influencing corrosion in steam heating systems, with data showing the extent and constitution of deposits in the heating system of an office building and a large hotel in New York City. These deposits were found to originate from the action of corrosion, and to contain little or no evidence of carryover from the boilers. The cause of the excessive corrosion was found to be the leakage of air into the vacuum return system. The amounts of oxygen and carbon dioxide associated with the steam were shown to be of insignificant importance as corrosive agents by the application of the law of Henry and Dalton, which states that the concentration of a gas dissolved in water is proportional to the partial pressure of the gas in contact with water. The cause of corrosion trouble in heating systems can be sought in the operation, and to a small extent in the design of the system, and not the quality of the steam used in the cases studied. Carbon dioxide contents in the steam were not over 15-20 p.p.m. and oxygen contents not over 0.3 to 0.5 c.c. per liter. Discussing the paper, it was pointed out that corrosion in heating systems is generally localized at some particular point or points and that in general it occurs at the bottoms of horizontal return lines.

Heat emission from iron and copper pipe was treated in a paper by F. C. Houghton and Carl Gutberlet, which reported the result of test work performed at the research laboratory of the A.S.H.V.E. The tests were made in a psychrometric room in which the air conditions were accurately controlled, and the heat emission from bare and covered iron pipe, and bare copper pipe, was observed in sizes of ¾-, 1-, 1¼- and 4-in., both horizontally and vertically placed.

It was found that the heat loss from bare copper pipe is approximately 54 per cent of the loss from bare black iron pipe of the same nominal size, and 203 per cent of the loss from iron pipe covered with four-ply air-cell insulation. The heat loss is approximately the same for horizontal and vertical pipe of the same size and material. The heat loss from pipe may be calculated from the Stefan-Boltzman and the Rice-Heilman equations with a high degree of accuracy by using the proper shape factor and emissivity coefficient, values for which were given in the report.

The first joint session with the A.S.R.E. was arranged by the heating and ventilating engineers and was devoted almost entirely to ventilating and air conditioning. A paper presented by

Professor Yaglow of Harvard University reported some of the work being done in regard to the ionic content of air. He disclosed that the ionic content of air in a room drops rapidly upon occupancy from about 300 ions per cubic centimeter to about 50 ions per cubic centimeter. About 160 c.f.m. of outdoor air per person is barely sufficient to maintain a normal ionic content. Additional research regarding the effect of the ionic content of air upon health is being undertaken by the Harvard School of Public Health with the cooperation of the A.S.H.V.E.

F. C. Houghten expressed the belief that the ionic content of air would be found to be the long-sought air vitamin. Other discussions indicated that too high or too low concentration of ions in the blood proves fatal.

A paper by J. H. Walker, S. S. Sanford and E. P. Wells reported tests made by the Detroit Edison Company in the Union Guardian Building, Detroit, to determine the factors that influence the cooling of office buildings. Sunshine through window glass is apparently the most important factor to contend with in cooling, and at times may account for as much as 75 per cent of the total cooling load. Because of this, office building cooling systems should be zoned so that the side of the building upon which sun is shining can be controlled separately from the others.

In the latitude of Detroit, design figures for the heat entering the walls and windows of an office building were given in the paper as follows:

Wall transmission,
3 B.t.u. per hr. per sq.ft. of wall
Glass transmission,
17 B.t.u. per hr. per sq.ft. of glass
Sunshine (east and west sides),
160 B.t.u. per hr. per sq.ft. of glass
Sunshine (south side),
140 B.t.u. per hr. per sq.ft. of glass

Shades Have No Influence

Discussion brought out that additional tests had been made to determine the effect of shades on the heat input to the room due to sunshine, which indicated that shades had practically no effect, just as much cooling being required with the shades up or down.

The influence of heat capacity and solar radiation on heat transmission has been the subject of research at the society's laboratory in Pittsburgh, the findings of which were reported by F. C. Houghten. They indicate that a large error may be introduced into calculations of heat transfer by failure to consider the periodic character of heat flow resulting from the diurnal movement of the sun and the heat capacity of the structure. For example, although the maximum outside surface temperature of 118 deg. was reached at about 1 p.m. the maximum heat flow and inside temperature of 88 deg. of a 6 in. concrete roof slab was not reached until 5 p.m. The paper contained a method for calculating the heat flow at any instant, which two discussors believed could be simplified.

A paper, "Acoustical Problems in the Heating and Ventilating of Buildings," by V. O. Knudsen, discussed the effect on speech and hearing of noises in auditoriums and theatres, indicated how noise may be measured, and suggested means for preventing noise from heating and ventilating equipment from being transmitted to ventilating ducts and room walls to the auditorium spaces.

All rotating or vibrating equipment should be mounted on flexible supports so resilient that the natural frequency of the mass of the equipment on its support will be low in comparison with the vibrations produced. Failure to do this has resulted in the amplification of the vibrations transmitted through the resilient material to the floor.

The advantages of room warming by radiation were discussed in a paper by A. H. Barker, various methods of placing and installing radiating surfaces being indicated.

The combustible nature of solid fuels with reference to draft requirements across the fire bed and rate of horizontal fire travel was discussed in a paper by R. V. Frost, indicating a considerable variation in the qualities of coal from the same mine or the same vein.

Two codes were presented for approval, one for testing and rating steam unit ventilators and the other on ventilation standards. Dr. Brabbee, discussing the first of these codes, expressed the belief that the nozzle method prescribed for measuring the air was cumbersome and questioned the advisability of limiting the air flow determination to one method. The code was referred to the society for letter ballot after the committee had considered the suggested changes.

Considerable objection was raised to the clause in the report on ventilation standards which prescribed that not less than 10 cu.ft. per minute of air per occupant shall be taken from an outdoor source. These standards were held over for the next meeting.

Announcement was made of the election of the following officers for the coming year: President, F. B. Rowley; treasurer, F. D. Mensing; first vice-president, W. T. Jones; second vice-president, C. V. Haynes; council—G. L. Larsen, J. F. McIntire, W. E. Stark, F. E. Giesecke.

THE increasing interest of the refrigeration industry in the use of refrigeration for air conditioning in both office buildings and domestic uses was evident at the 27th annual meeting of the American Society of Refrigerating Engineers held at Cleveland, Jan. 26 to 28.

Papers presented that apply to air conditioning in addition to those at the joint meeting sponsored by the A.S.H.V.E. were "Survey of Ice for Air Cooling Applications," by R. T. Brezzolava; "Summer Air Conditioning of Residences," by E. D. Milener; "Application of Refrigeration to Heating and Cooling of Homes," by A. R. Stevenson, Jr., F. H. Faust and E. W. Roessler; and "Air Conditioning as Applied to Cold Storage and a New Psychrometric Chart," by C. A. Bulkeley.

Various equipment available for using ice as a cooling medium for air conditioning were described in the paper by Mr. Brizzolava, which also indicated the conditions under which the use of ice is economically justifiable.

Heating By Refrigeration Limited

The paper on the use of refrigeration for house heating pointed out the difficulties that confront this method of heating, the most important of which are caused by the absence in most cases of any heat source other than air. Thus on cold days when heat is most needed the capacity of the refrigeration heating unit is reduced, as is also its efficiency. This factor will in general limit the use of this system of heating to relatively warm climate.

The paper concerning air conditioning of cold-storage rooms was presented in two parts. The first portion dealt with a new psychrometric chart extended to temperatures of 35 deg. F. In the second portion of the paper the importance of maintaining high relative humidities in cold-storage rooms for food products was stressed. Cooling of storage rooms with bunker coils tends to reduce humidity. The paper recommended cooling by means of brine spray washers in the same manner as used for air conditioning of theaters.

The question of salt being carried into the room from the washer and deposited on the foods stored was brought up in the discussion, but the author replied that during storage for a period of several weeks no trace of salt could be found on foodstuffs by taste.

A paper of interest to heating and power, as well as refrigerating, engineers was presented by J. L. Gregg, concerning the properties of metal foil as an insulating material. A general discussion of the theory involved and an equation for calculating heat conductivity of foil insulation were given. Experimental determination of conductivity and a number of various ways of using foil insulation were reported. At 106 deg. aluminum foil 0.05 in. thick separated by wooden lattice to give an air space of 0.5 in., the lattice occupying 6 per cent of the space, gave conductivities of about 0.24 B.t.u. per hour per square foot per degree Fahrenheit per inch thickness. This type of insulation weighs 2 to 4 lb. per cubic foot.

C. R. Neeson, in a paper, "Oil Engine Compression Costs," described a combined diesel engine compressor unit and compared the cost of its operation with the cost of an electrically operated plant. With oil at five cents a gallon and electricity at one cent a kilowatt-hour the savings by the diesel plant were shown to be $4,356 in the manufacture of 26,990 tons of ice a year.

A somewhat similar paper by F. W. Laverty discussed the advantages of using natural-gas engines for refrigerating plants, described types of gas engines and indicated in a comparison that a 30 per cent saving can be made over a motor-operated plant by the use of natural gas.

WHAT'S NEW IN PLANT EQUIPMENT

Pressure-Reservoir Type Guide-Rail Lubricator

TO OVERCOME the many objections to hand lubrication of elevator guide rails, several types of automatic lubricators have been developed. In some of these grease is supplied directly to the guide rails from the lubricator reservoir, while in others the grease is applied under pressure by a grease gun. Lubricators for applying oils of various viscosities to the rails are available in different forms. In some the oil is syphoned from the reservoir to the guide rails. A new type has recently been made available by Yvan Zenon, 244-22 136th Ave., Rosedale, N. Y., that applies a heavy oil or light grease under a positive pressure to the guide rails from a central reservoir on the car and on the counterweight crosshead.

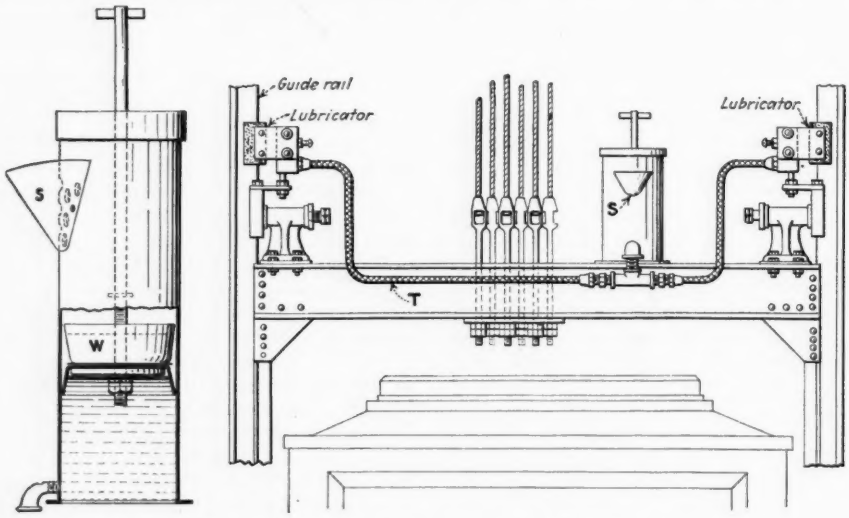


Fig. 1—Section through lubricant reservoir and general arrangement of lubricating system applied to the car guide shoes

The reservoir for the new system is shown in Fig. 1. It contains a weighted piston *W* that rests on the surface of the lubricant and is free to move in the reservoir. The weight on the piston is such as to maintain a considerable head on the lubricant where it is applied to the guide rails. The general arrangement of the reservoir on a car's crosshead and how it is connected to the lubricant distributors by metal tubes is shown in the right-hand view. To replenish the lubricant in the reservoir it is only necessary to pull the piston to the top of the reservoir and fill the latter by pouring the lubricant into spout *S*.

A section through one of the lubricant distributors is shown in Fig. 2. Oil is led to the rail from the reservoir by tube *T* through valve *V* and into tube *A*. Tube *A* is made of fiber and is held against the guide rails with a spring *B*. A distributor *D* made of fibrous material is held against each side of the guide rails, and is used to distribute the lubricant properly on the surface of the rails. Tube *A* seals on the front of the guide rail so that when the car is at rest no lubricant is delivered to the rail. When the car is in motion the lubricant will be fed to the rail by the action of the moving surface and because of the pressure exerted on the lubricant by the piston in the reservoir. Part of the lubricant fed to the rail is picked up by the distributors and applied to its side. The rate at which lubricant is fed to the rails when the car is in motion is adjusted by valve *V*. This valve also allows adjusting for a change in the viscosity of the lubricant used. A heavy oil is recommended for the lubricator, although various grades may be used to suit special local conditions.

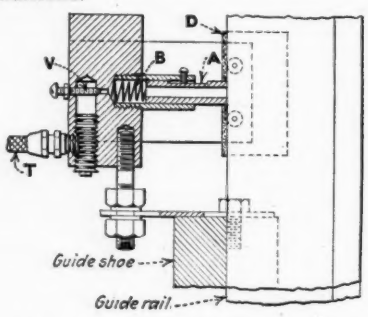


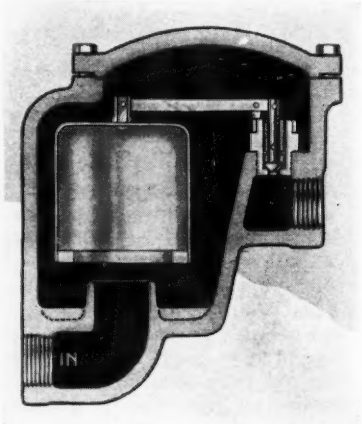
Fig. 2—Section through lubricant distributor

Apex Inverted-Bucket Steam Trap

IN THE accompanying illustration is shown a section through the new Apex Class S T inverted-bucket steam trap perfected recently for a wide variety and range of draining or trapping service by the Apex Regulator Company, Division of the Fisher Governor Company, Marshalltown, Iowa. Simplicity of design, rugged construction, non-air binding and side piping connections independent of the cover are features. This design of trap may be used for a maximum pressure of 125 lb. and temperature of 450 deg. It is made for pipe sizes ranging from $\frac{3}{8}$ to 1 inch.

In the construction, trap bodies are made of semi-steel, the bucket of formed bronze, and the valves of stainless steel to resist corrosion and wear.

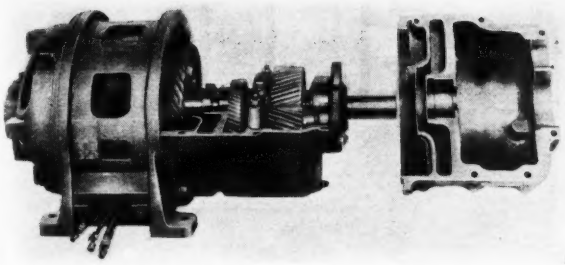
Through the inlet at the bottom, condensation rises in the trap body, trapping air and steam in the inverted bucket. As the latter is relatively large and the leverage powerful, the buoyancy thus given the open-ended bucket permits the use of a sizable valve port to insure large discharge capacity without sacrificing the positiveness of operation. As the condensation continues to rise the air is forced ahead of it through an opening in the top of the bucket, so that the latter loses its buoyancy, and, sinking of its own weight, opens the valve. As the condensation recedes, air and steam again enter the bucket to give it the buoyancy necessary to close the valve. Because of its construction the trap has ability successfully to handle and discharge large volumes of air without air-binding, so that it is especially applicable for services presenting such a problem.



Section through Apex inverted-bucket steam trap

Unit-Built Motors and Speed Reducers

NEW DRIVES, known as Gearmotors, consisting of speed reducers combined with motors forming self-contained units only a few inches longer over-all than motors alone have been made available by the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.



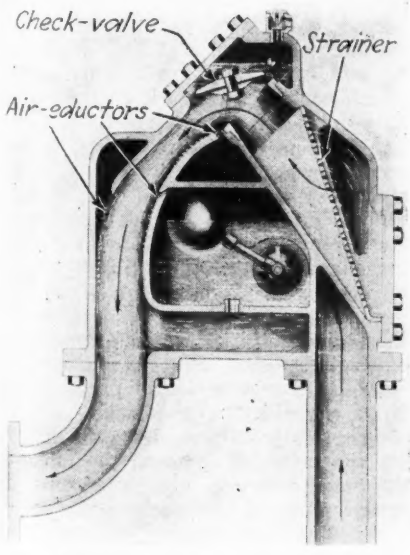
Gearmotors in sizes from ¼ to 15 hp. have output speeds ranging from 69 to 1,550 r.p.m.

Each unit includes a Type CS induction motor and a double-reduction, nonplanetary helical-gear speed reducer built onto the one-piece motor frame forming a rigid assembly supported entirely by the motor feet.

An improvement in motor construction incorporated in these unit drives is the pre-wound primary core which is separable from the stator frame. This feature permits quick and inexpensive change of motor speed, voltage and phase. The simple speed-reducing mechanism is fully inclosed in a two-piece housing bolted to the motor frame. All gear and pinion shafts are supported on roller bearings, and the complete unit is lubricated by splash system. Gearmotors are built in sizes of ½ to 15 hp., with a selection of output speeds ranging from 69 to 1,550 revolutions per minute.

Suction Line Primer With Strainer and Check Valve

A NEW priming device for centrifugal pumps has been announced by Barrett, Haentjens & Company, Hazleton, Penna. The device combines in one compact casting a check valve, strainer and air-removing device. It is built in various sizes, for a maximum capacity of 1,500 g.p.m. and a maximum operating head of 200 ft. When furnished with a special control panel it makes possible automatic operation of the pump with complete protection against loss of water, air leaks and break of the column line.

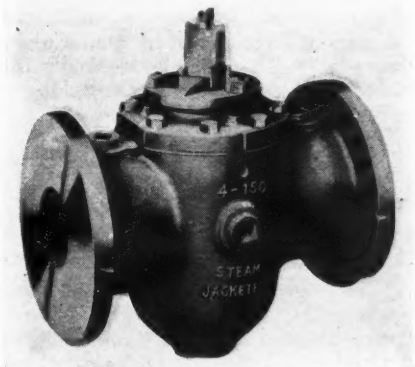


Sectional view of suction line primer

Semi-Steel Steam-Jacketed Valves

FOR USE in conjunction with steam-jacketed piping, a new series of Nordstrom steam-jacketed valves is offered in semi-steel in sizes from 2 to 4 in., inclusive.

These valves are for 150 lb. line working pressure, and the jackets are designed for a maximum saturated-steam pressure of 100 lb. with maximum temperature 337 deg. The valve embodies a lubricated plug cock, and, by use of the steam-jacket housing, permits the handling of fluids of highly viscous nature or requiring an elevated temperature for proper transmission. It is cast with a double-walled body, the heating space thus formed entirely surrounding the body. Special lubricants



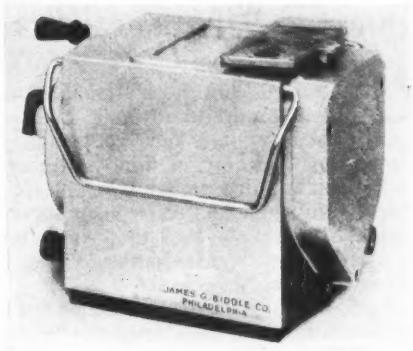
Nordstrom steam-jacketed plug cock

have been developed for use in valves carrying high temperatures, so that the lubricant retains the proper consistency and provides the correct film between the plug and body. The valve is manufactured by Merco Nordstrom Valve Company, 343 Sansome St., San Francisco, Calif.

Direct-Reading Ground Tester

TO MEET the need for a small, lightweight, direct-reading instrument for measuring ground connection resistance, James G. Biddle Company, 1211 Arch St., Philadelphia, has developed the "Meg" ground tester illustrated. This instrument operates on the same principle as the "Megger" ground tester (which it supplements), having a self-contained hand generator that furnishes alternating current for the test, and a direct-reading pointer-type ohmmeter. It is only necessary to connect the instrument to the ground under test and to two reference grounds, turn the crank and read the ground resistance in ohms. The instrument is not affected by polarization or electrolysis, or by stray current in the earth, and the reference ground connections do not have to be less than 200 ohms each.

It is available with ranges up to 300, 600 and 1,000 ohms. The scales are logarithmic in character, being "opened up" at the lower end and calibrated in single ohms up to at least 20, then in larger units up to full scale values.



"Meg" ground tester

Across-the-Line Explosion-Proof Starter

KNOWN as No. 1 Type ZEO, the starter illustrated is approved for Class 1, Group D, hazardous locations. The inclosing case is strong and tight enough to prevent the transmission to surrounding atmosphere of any flame that may occur within the case. The contactor mechanism and overload relays are mounted on a slate base which is removable from the case. The main contacts and overload relay contacts are oil-immersed, and all working parts are kept well lubricated and protected from corrosion by capillary attraction of the oil.

The maximum ratings of this starter, which is put out by the Electric Controller & Manufacturing Company, of Cleveland, Ohio, are 5 hp., 110 volts, and 10 hp., 220, 440 and 550 volts. Explosion-proof push buttons are available for controlling these starters.

Motor starter for hazardous locations

NEWS of the FIELD

New York, California and Wisconsin Commissioners Threaten Withdrawal from National Association

CHARGING that the National Association of Railroad and Utilities Commissions as it is now conducted is "imperiling state regulation," members of the public utility commissions of New York, California and Wisconsin served formal notice Feb. 1 of their intention to secede from the association "unless it changes its course."

Announcement of the threatened withdrawal was made in a letter addressed to the entire membership of the national body. The letter condemned participation of officials and representatives of public utility companies in the annual conventions of the association as injurious to utility regulation and destructive of public confidence in regulatory bodies. It also protested against holding the conventions in pleasure resorts and suggested Washington as a permanent meeting place. Further objection was made to the practice of having the association "supervise" the official publications of the utility industry.

The object of the communication, it was said, is to pave the way for an effort to eliminate, at the next annual meeting, scheduled for Hot Springs, Ark., next summer, the practices complained of. Last summer at the meeting in Richmond, Va., several commissioners tried to put through the proposed reforms, but were overwhelmingly outvoted.

The letter declares that the association kept from the public records of the proceedings the debate on the defeated proposal to exclude company officials and representatives from the conventions. This debate indicated that some of these utility guests "by endeavoring to influence action in the convention, by furnishing entertainment to commissioners, and by similar activities, had seriously impaired the value of the conventions and were bringing the good name of the entire association into disrepute."

The resolution was reported to the executive committee, the letter declares, which reported against adoption, but said that the committee would try to carry out its spirit.

The letter then discusses the defeat of a resolution proposing that Washington be made the permanent convention center. The debate on this resolution brought out the argument that "the junketing aspects of the association conventions have injured public confidence in regulation." The letter protests specifically against the practice of holding the meetings at such pleasure resorts as Miami, Glacier National Park, Asheville, N. C., and other recreation centers. The "junkets" are also attacked as contrary to sound principles of economy in expenditure of public funds.

The resolution to discontinue "supervision" of the *Public Utilities Fortnightly* and the *Public Utility Reports*, both industry publications, was also presented at Richmond. Its purpose, the letter declares, was to put the association in a position where it would not be "favoring, endorsing or supervising any commercial publication that desired to print the decisions of the commissions." It was especially designed, the letter adds, "to free the association of the quite natural innuendo attached to supervising and endorsing a publication financed and controlled by public utility interests." The Richmond convention tabled the resolution without discussion.

Winnipeg Heating System Described at E.I.C. Meeting

AT THE 46TH annual meeting of the Engineering Institute of Canada, held last week in Toronto, a comprehensive description of the central heating system of the City of Winnipeg, which is generally regarded as one of the most up-to-date systems on the continent, was given in a paper by G. W. Oliver, of the Winnipeg Hydro-Electric System.

The principal reason for the establishment of the plant, Mr. Oliver said, was the desire to utilize the existing boilers of the steam-electric stand-by plant during the winter months, in this way obtaining additional revenue from the outlay incurred. The equipment of the station includes four water-tube boilers fired with pulverized coal and together capable of producing 440,000 lb. of steam per hour at 250 lb. pressure. There are also three electric boilers, each taking 7,500 kw., with a total capacity of 62,000 lb. of steam per hour.

These boilers serve to flatten out the load curve of the hydro-electric system by using off-peak energy, in this way substantially increasing the load factor of the hydro-electric system. The three turbine-generators, having a total rating of 11,000 kw. exhaust to condensers and the steam they use is not employed in the heating system, which is supplied by live steam both from the electric and coal-fired boilers. The city steam distribution system consists of a loop main and looped branches, laid out in this way with a view to eliminating dead ends. The mains range in size from 14 to 4 in. in diameter. They are laid in concrete conduit and expansion is provided for by use of slip joints.

All the turbine-room auxiliaries are electrically driven with the exception of emergency oil pumps, and each turbine is fitted with an atmospheric exhaust relief valve for use in the event of either the surface condensers or feed heater becoming crippled. The electrical sub-station serves the dual purpose of being the control gallery for the turbine room and at the same time sub-station No. 6 of the hydro-electric system.

The heating system supplies the business area of Winnipeg, and 246 buildings are at present connected. The steam consumption ranges from 250 to 650 lb. per sq.ft. of radiation per season. Steam reaches the various buildings at a pressure of approximately 40 lb., which is reduced on the customer's premises to suit conditions. No steam is supplied for power purposes.

May Finish Hoover Dam a Year Ahead of Schedule

HOOVER DAM may be completed one year earlier than expected, Commissioner Elwood Mead, of the Bureau Reclamation, stated Jan. 27. This prediction, he said, was based on the speed with which construction work on the dam is going ahead at the present time.

According to latest reports, a new record for the amount of excavation in a single day was established Jan. 20 at the Hoover Dam. On that day 256 linear feet of progress was made in the enlarged tunnels. More than 16,000 cu.yd. of rock were removed in a 24-hour period. During the week nearly 1,700 linear feet of 41x56 ft. heading were excavated. Only 570 ft. remained on Jan. 23 between the headings in tunnel No. 2 and 410 ft. in tunnel No. 3.

Progress is being made on the designs for the bulkhead gates at the inlets of the outer diversion tunnels and for the stoney gates at the outlet ends of the inner diversion tunnels. Alternative studies are being made on different features of the outlet works. Particular at-

tention is being given to the fabrication and installation of steel penstocks for the pressure tunnels.

Work has been concentrated on penstock studies in order that definite locations of tunnels may be fixed. There have been extended discussions of steel penstock design. The Southern California Edison Company has advised that it will require six 80,000 kva. units. The City of Los Angeles has not advised as yet the number or capacity of the units it will need.

Boston Societies Organize Work Bureau for Engineers

ORGANIZATION of the Emergency Planning and Research Bureau has just been announced by the Boston Society of Architects and the Engineering Societies of Boston. The purpose of the new bureau is to afford relief to unemployed members of the engineering and architectural professions by providing work, adapted to their technical training, on needed public improvements in Boston and the surrounding region.

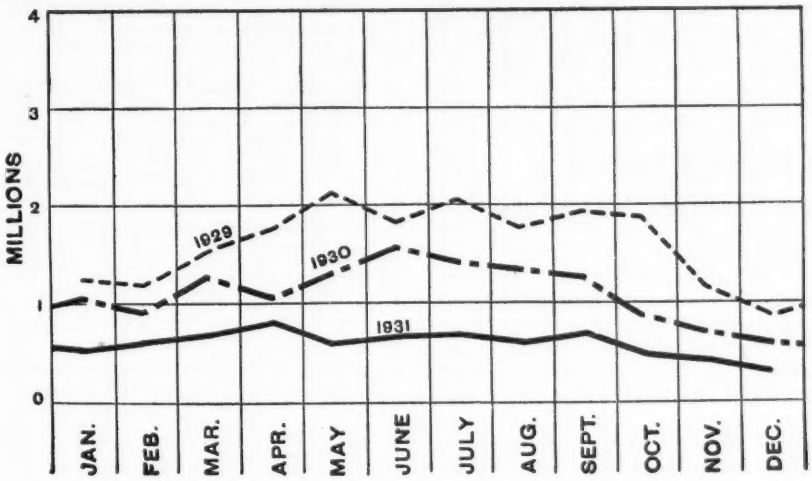
In each profession steps are being taken to secure contributions, and so far about 60 men have been given employment. The work is being carried on by committees of each group. For the architects, the committee is composed of William S. Parker, chairman; Hubert G. Ripley; and James F. Clapp. Under the engineering societies there are five working units, headed as follows: Frank M. Gunby, executive committee; Dugald C. Jackson, finance committee; Ralph W. Horne, registration committee; James P. Alexander, administration committee; and Morton C. Tuttle, publicity committee.

"The development of larger projects of city and regional planning will depend upon the means and personnel available for their financing and direction," the bureau states. "There are, undoubtedly, several hundred men technically trained in the various branches of engineering and architectural work that can be given useful employment at small but helpful salaries, if the necessary funds can be obtained."

Yonkers Carpet Works Enlarges Power Plant

ALEXANDER SMITH & SON have purchased recently additional equipment to increase the output of the power plant for their carpet works at Yonkers, N. Y. This equipment includes a 4,000-kw. turbine-generator, a 4,000-sq.ft. surface condenser, two 2-stage LeBlanc steam-air pumps, two 200 g.p.m. 1,750-r.p.m. condensate pumps, a 15-hp. motor for driving pumps, one 12.2-hp. impulse-type turbine for driving pump, and a twelve-panel switchboard.

1931 Boiler Sales 45 Per Cent Under 1930; Stokers Off 30 Per Cent; Pulverizers Decline



Total heating surface of boilers sold in millions of square feet

SALES of boilers during 1931 were approximately 45 per cent under those for 1930, mechanical stoker sales dropped 30 per cent in the same period, while sales of pulverizers continued to decline during the year, according to reports issued last week by the United States Bureau of the Census.

In 1931 new orders were placed for 8,017 boilers of 7,229,618 sq.ft., compared with orders for 13,166 boilers of 13,469,893 sq.ft. in 1930. As shown by the curve of heating surface, sales held up fairly evenly during the first half of last year, took a slight spurt in the third quarter and fell off appreciably in the last quarter. The following table gives the number, kind and square footage of all boilers sold in 1931 and 1930:

Kind	1931 No.	1931 Sq.Ft.	1930 No.	1930 Sq.Ft.
Stationary:				
Water tube...	672	2,838,608	1,070	5,562,877
Horizontal return tubular	487	612,802	879	1,179,486
Vertical fire tube.....	626	173,106	1,140	340,470
Locomotive (not railway)	103	87,030	167	145,251
Steel heating..	5,201	2,300,394	8,081	3,546,144
Oil country...	399	451,340	994	1,135,099
Self-contained portable....	302	233,888	438	310,027
Miscellaneous	65	33,004	140	117,132
Total.....	7,855	6,730,172	12,909	12,336,486
Marine				
Water tube...	88	455,987	172	1,072,103
Pipe.....	7	8,159	3	3,217
Scotch.....	57	25,630	75	54,159
Miscellaneous	10	9,670	7	3,928
Total.....	8,017	7,229,618	13,166	13,469,893

Sales of mechanical stokers of over 300 lb. capacity in 1931 totaled 988 stokers of 247,812 hp., compared with 1,179 stokers of 365,664 hp. in 1930. Of those sold last year 478 were for installation under water-tube boilers of 1,704,210 sq.ft., and 510 were for fire-tube boilers of 773,910 sq.ft. In addition, the new classification of the Census Bureau shows that 1,118 stokers of 200 to 300 lb. capacity each were sold in 1931, together with 1,431 of 100 to 200 lb. and 6,047 of less than 100 lb. capacity.

Last year sales of pulverizers for boiler installations aggregated 115 pulverizers with a total capacity of 740,260 lb. of coal per hour contract. That orders for pulverizers fell off sharply in the fourth quarter is evidenced by the fact that only 12 pulverizers of 57,000 lb. total capacity were sold during that period. Of the total for the year 8 pulverizers having a combined capacity of 250,000 lb. were for use in the storage system to fire water-tube boilers; 72 with a total capacity of 450,960 lb. were for use in the unit system to fire water-tube boilers; and 35 having a capacity of 39,300 lb. were for use in the unit system with fire-tube boilers. Comparable figures for 1930 are not available, as the Census Bureau did not start reporting pulverizer sales until that year.

Utilities Protest Against Federal Tax on Power

IN OPPOSITION to a proposed tax on power consumption, spokesmen for the power utilities and representatives of electric railways and other large consumers of electric current stated to the House Ways and Means Committee on Feb. 3 that such a tax would be unjust and discriminatory and would be disappointing from a revenue producing standpoint. The point was also made that a percentage tax upon electric power bills would penalize small industrial plants that are not in a position to make their own power. Larger competitors of these plants, on the other hand, could evade the tax by making their own power.

At the outset of the hearing, Representative Crisp of Georgia, acting chairman of the committee, made it clear that no proposal for a tax of one-half cent per kilowatt-hour is being entertained. Mr. Crisp conceded that such a tax would be unreasonable and confiscatory. For the benefit of those who attended the hearing, he stated

that the only proposal under consideration was for a tax of from 1 to 10 per cent applied upon electric power bills for domestic and industrial uses. This tax would be assessed against the customers of municipally owned power companies as well as against those of privately owned power companies.

Lighting Conference in New Orleans Next Week

A LIGHTING CONFERENCE under the auspices of the Southwestern Geographic Division of the National Electric Light Association, will be held in New Orleans during the third week of February. This conference will consist of discussions by utility representatives on various lighting activities, methods of promotion, and details of departmental organization. In addition to consideration of those problems, there will be eleven lectures which will treat of the last word in lighting development.

Speakers will include engineers who are noted for their work in special fields of lighting activity. Discussions of lighting department activities will be made by well known public utility engineers of the southwest, and several architects will add their viewpoints in the lectures and discussions.

Those interested may obtain further details of the conference from M. F. Canning, New Orleans Public Service, Inc., New Orleans, La.

Order 76 Elevators for Radio City Building

IN AWARDING to the Westinghouse Electric Elevator Company the contract to install 76 full automatic elevators in the 70-story office building, which is to be the largest of the group of structures in the Rockefeller Midtown Building Center, popularly known as Radio City, in New York City, the Metropolitan Square Corporation (Mr. Rockefeller's holding company) has arranged for the largest number of elevators ever installed in a single building. These elevators will cost approximately $2,500,000 to install, and when completed, they will handle nearly 43,000 persons daily.

Seventy-four of the elevators will be used for general passenger service, which include 12 for special service from the shopping basement and ground floor levels to the National Broadcasting offices and studios between the 3rd and 15th floors; 24 of the passenger elevators will operate at a speed of 1,200 ft. a minute, which is now allowed under the revised New York Building Code.

Operating on a full schedule from 8 in the morning to 6:30 in the evening, the 76 elevators in this building will travel over 2,100 miles a day, or about 760,000 miles a year.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meetings at Milwaukee, Wis., March 14-16, and Providence, R. I., May 4-7. Annual summer convention at Cleveland, Ohio, June 20-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Boiler Manufacturers Association. Mid-winter meeting at the Hotel Cleveland, Cleveland, Ohio, Feb. 11. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

American Society for Testing Materials. Committees group meetings in Cleveland, Ohio, March 7-11. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

American Welding Society. Annual meeting in New York City, Apr. 27-29. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers. Annual convention in Pittsburgh, Pa., June 20-24. Managing Director, John F. Kelly, Empire Building, Pittsburgh.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Bridgeport Section. Meeting at the University Club, Feb. 25 at 8 p.m. Subject: "Vibration of Internal-Combustion Engines," J. Ormontroyd.

A.S.M.E., Metropolitan Section. Meeting at the Engineering Societies Building, Feb. 18 at 8 p.m. Subject: "Research on Cyclone Dust Collectors," L. C. Whiton, Jr. Dinner meeting at Cavanagh's Restaurant, Feb. 25 at 6:30 p.m. Subject: "The Automatic Diesel Plant for City Buildings," C. F. Strong.

A.S.T.M., New York Section. Joint meeting with A.I.M.E. at the engineering Societies Building, Feb. 18 at 8 p.m. Subjects: "Limits of Our Knowledge of the Properties of Metals," F. O. Clements; "Test Results and Service Values of Metals," H. F. Moore; and demonstration of welding tests.

A.W.S., Philadelphia Section. Meeting at the Engineers Club, Feb. 15 at 8 p.m. Subject: "Some Aspects of Welded Fabrication From the Viewpoint of Both the Designing Engineer and the Welding Supervisor," J. C. Cumberland.

Engineers Club of Philadelphia. Luncheon meeting, Feb. 16 at 12:30 p.m. Subject: "Power Problems—Past and Future," A. G. Christie.

N.A.P.R.E. First Pacific Coast conference at the Civic Auditorium, San Francisco, Calif., Feb. 17-18. Washington, Oregon, California and Arizona chapters will take part.

Beauharnois Officials Resign As Reorganization Progresses

BEAUHARNOIS MATTERS are again coming to the fore at Ottawa, and as a result of recent meetings between members of the government and the Beauharnois Power Corporation, it is understood that a mutually acceptable plan for reorganizing the company and for the imposition of conditions upon the continuance of the development, particularly as it effects navigation, has been devised.

Return of a large block of stock to the treasury of the company and the resignation of W. L. McDougald, R. O. Sweezey and R. C. A. Henry, directors, and Hugh B. Griffith, secretary-treasurer, marked developments in the company's reorganization last week.

It is understood that all the conditions attaching to the original sanction by the government are being renewed, in substance, and that new and more onerous ones are being added. In the first order, the federal government was to be entitled to the free use of the canal for navigation purposes. It is now understood that something more than a guarantee of this nature is being demanded by the government, and that the conclusion may find ownership virtually vested in the government, though without prejudice to the company's use of the power.

Rumors also hint at some measure of control over rates, but this is likely to be bitterly resisted as being entirely within provincial jurisdiction.

Purchasing Agents to Meet In Birmingham, Feb. 18-20

THE PUBLIC UTILITY GROUP of the National Association of Purchasing Agents will hold its mid-year conference at the Tutwiler Hotel, Birmingham, Ala., on Feb. 18 to 20, inclusive. Five business sessions are scheduled on the program, together with several entertainment features and inspection trips to the American Cast Iron Pipe Company's factory and the Mitchell Dam plant of the Alabama Power Company.

Among the subjects to be discussed are: "The Importance of Buyer and Customer Contact in the Work of Our Public Relations," C. E. Smith; "What Purchasing Agents Should Know About the Underwriters' Laboratories," W. J. Alcock; "The Manufacturer's Responsibility in Machinery Contracts," F. F. Rohrer; "Relation of the Purchasing Agent to the Safety Department in the Matter of Specifications," W. R. Lloyd; "The Hard-Boiled P. A.," L. F. Boffey; "New Developments in Alloy Steel," J. B. Hammond.

In addition Judge Samuel F. Hobbs, of the Muscle Shoals Commission, will speak on "The Recent Report to President Hoover," and Robert Mangum, of the Alabama Power Company, will talk about "Uncommon Common Sense."

Personals

JOHN C. PARKER, since 1926 vice-president in charge of engineering of the Brooklyn Edison Company, was elected president Feb. 2 at a meeting of the trustees of the parent organization, the Consolidated Gas Company of New York. At the same meeting Harry L. Snyder, vice-president and general manager of the New York & Queens Electric Light & Power Company, was elected president of that subsidiary. Both Mr. Parker and Mr. Snyder succeed Matthew S. Sloan, who resigned Jan. 28.

HARRY A. KIDDER, superintendent of motive power for the Interborough Rapid Transit Company, New York, was recently elected president of the United Engineering Trustees, Inc. Harold V. Coes, consulting management engineer of Ford, Bacon & Davis, Inc., was elected first vice-president, and Arthur S. Dwight, president of the Dwight & Lloyd Companies, was chosen second vice-president. Alfred D. Flinn was re-elected secretary.

FRANK J. SPRAGUE, president of the Sprague Safety Control & Signal Corporation, New York City, received honorary membership in the American Institute of Electrical Engineers at the latter's recent winter convention in New York. A past-president of the institute, Dr. Sprague has long been prominent in the electrical field.

RALPH A. SHERMAN, fuel engineer of the Battelle Memorial Institute, Columbus, Ohio, has been elected chairman of the A.S.M.E. Fuels Division for 1932. WILLIAM G. CHRISTY, chief smoke abatement engineer for Hudson County, N. J., has been elected secretary. Mr. Christy takes the place of A. D. BLAKE, managing editor of *Power*, who has been secretary for several years and who still remains a member of the division's executive committee. K. M. IRWIN, engineer with the Philadelphia Electric Company, has been chosen for the new five-year term on the executive committee, and will also be chairman of the division's papers committee.

ADDISON W. LEE, formerly general superintendent of the Louisville Gas & Electric Company, was recently elected vice-president in charge of operations to succeed the late LEWIS S. STRONG. E. D. WOOD, who has been general operating engineer, succeeds Mr. Lee as general superintendent.

EDWARD H. SNIFFIN, assistant to the vice-president of the Westinghouse Electric & Manufacturing Company, recently went to Chicago as special representative in connection with the World's Fair to be held there in 1933. He has been delegated to study the company's participation in the "Century of Progress," which will be featured at the fair, and he will remain in Chicago until after the exposition is over.

How's Business?

ON BALANCE the level of business activity shows signs of slight weakening as the second month of the year starts. In only a few lines—steel, shoes, textiles, automobiles—have there been any indications of the usual spring stimulus so far, and these have been mild. Steel production of late has slackened slightly; carloadings and electric power production (1,588,967,000 kw.-hr. for the week ended Jan. 30, according to the N.E.L.A., still show no improvement; commodity price averages have slowly sagged since the outset of the year. The sharp decline in building contracts, particularly in public works projects, during January is depressing. —*The Business Week*, Feb. 10.

Business Notes

RILEY STOKER CORPORATION, Worcester, Mass., announces the appointment of J. H. Rohrer and H. W. Hendrix as sales engineers. They will be located at the Philadelphia office.

NORTHERN EQUIPMENT COMPANY, Erie, Pa., announces the appointment as sales representative of the Hopton Company, 404 Denison Building, Syracuse, N. Y.

LINK-BELT COMPANY, Chicago, Ill., has just issued a twelve-page art-gravure calendar, 24 x 15 in., each page of which illustrates material-handling, screening or power transmission equipment. A copy of the calendar will be sent to anyone requesting it on a business letterhead.

RELIANCE ELECTRIC & ENGINEERING COMPANY, Cleveland, Ohio, announces the following branch office changes: The Cincinnati office has been moved to 2905 Carew Tower, with J. L. Van Nort in charge; H. A. Holmes has been made salesman in charge of the Toledo office; and L. M. Dunning has been transferred to the Cleveland district office.

VICTOR CHEMICAL WORKS, Chicago, Ill., announces the removal of its general offices to the Board of Trade Building, 141 West Jackson Boulevard.

CHAS. A. SCHIEREN COMPANY, New York City, recently moved its Boston branch office to 186 Lincoln Street.

TIMKEN ROLLER BEARING COMPANY, Canton, Ohio, announces that William E. Umstattd, formerly factory manager, has been appointed executive vice-president. Henry H. Timken, Jr., who has been serving as assistant works manager for the past two years, has been made assistant to the president of the company.

LUKENWELD, INC., Coatesville, Pa., has appointed Henry H. Peck, formerly with the Standard Steel Works Company, Burnham, Pa., as manager of sales to succeed John S. Bleecker, who has been made manager of sales research and advertising for Lukens Steel Company, the parent organization. Lukenweld has also appointed two new representatives to handle sales and service of its products: Welding Engineering Company, 2872 North 41st St., Milwaukee, Wis., and Marvine Gorham, Jackson Building, Buffalo, N. Y.

Trade Catalogs

STEAM HEATING—The 1932 edition of "Modern Heating," just published by Warren Webster & Company, Camden, N. J., describes and illustrates the company's improved systems of steam heating, in which metered orifices are used to secure equalized or balanced distribution of steam. Control equipment, radiator valves, traps and system equipment are also described in the bulletin.

BOILERS—Construction features of the C-E VM type bent-tube boiler are described in a new catalog of the Combustion Engineering Corporation, 200 Madison Ave., New York, N. Y. This boiler is available in sizes ranging from 1,215 to 5,328 sq.ft., and is especially adapted to plants having limited space conditions.

DEEP-WELL PUMPS—Bulletin 36, just issued by A. D. Cook, Inc., Lawrenceburg, Ind., contains detailed information on the Type WP deep-well turbine. Many illustrations are included, showing design features of the pump and many actual installations, as well as the laboratory facilities of the company.

SWITCHBOARD DEVICES — General Electric Company, Schenectady, N. Y., has recently published four bulletins on switchboard and control devices, as follows: GEA-924B covering many types of indoor bus supports; GEA-1192A on galvanized beam clamps for mounting switches and insulators; GEA-1521 on low-temperature fuse links for distribution cutouts; and GEA-1084A on plate-type field rheostats.

Buffalo N.A.P.E. Wants Books

WORD has just been received from R. G. Summers, librarian of the Keystone Association, No. 16, of the National Association of Power Engineers, that the local chapter is desirous of obtaining books, catalogs and operating instruction manuals for its library. These may be sent to Mr. Summers at 284 Franklin St., Buffalo, N. Y., or directly to the local association's headquarters at 796-798 Ellicott Street.

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Birmingham—Birmingham Gas Co., 317 North 20th St., subsidiary of A. E. Fitkin & Co., Ltd., 39 Broadway, New York, N. Y., plans gas plant improvements and line extensions here.

Ark., Pine Bluff—City is having preliminary plans prepared for repairs and extensions to sewage system including new disposal plant, pumps, etc. Estimated cost $125,000. C. Wright, City Hall, is engineer.

Colo., Colorado Springs—City plans to expend $200,000 for enlarging municipal steam plant, extending building and installing steam turbine and boiler capacity to equal that now in use.

Del., Wilmington—Delaware Electric Power Co., 834 Market St., subsidiary of United Gas Improvement Corp., 1401 Arch St., Philadelphia, Pa., receiving bids for electric sub-station improvements and electric distribution line extensions, etc., here. Estimated total cost $615,000.

Fla., Jacksonville — Jacksonville Gas Co., Jacksonville, subsidiary of A. E. Fitkin Co. Ltd., 39 Broadway, New York, plans improvements and extensions to gas plant here.

Ill., Chicago—State of Illinois, Department of Purchase & Construction, Capitol Bldg., Springfield, awarded general contract for construction of a 3 story boiler house and laundry building at Sangamon and Adams Sts., here, to Schmidt Bros., 22 East Huron St., Chicago. Estimated cost $150,000.

Ill., Chicago—Treasury Department, Office of Supervising Architect, Washington, D. C., plans and specifications ready about March 1 for construction of a 7 story, 125 x 176 ft. custom house with foundaitons capable of carrying four additional stories, at Canal and Harrison Sts., including boiler room sufficient to heat new $15,000,000 post office adjacent to new construction. Nimmons, Carr & Wright, 333 North Michigan Ave. and Burnham Bros. Inc., 160 North La Salle St., are associate architects.

Ill., Joliet—State of Illinois, Department of Purchase & Construction, H. H. Kohn, Dir., Capitol Bldg., Springfield, will receive bids until February 16 for construction of a stone crushing plant here, to include electric hoist and accessories, hoist motor, control system, hopper and shutes, dust elevator, storage bins, gates and spouts, electric travel chain hoist, signal system, etc. Estimated cost $40,000. C. Herrick Hammond, 160 North La Salle St., Chicago. Engineering Service Co., 605 North Michigan Ave., Chicago, is engineer.

Ill., Moline—City is having plans prepared for waterworks improvements including filter plant, electrical and pumping equipment, new 3,000,000 gal. storage tank, repairing present storage tank, etc. Estimated cost $200,000. Pearse, Greely & Hansen, 6 North Michigan Ave., Chicago, are engineers.

Idaho, Coeur d'Alene — City voted $60,000 bonds for construction of municipal electric light and power plant.

Ia., Winterset — City awarded contract for 750 hp. 6 cycle, 225 r.p.m. Diesel engine to Electric Equipment Co., Des Moines, $37,091.

Mass., Boston — Hospital Department, plans improvements to power plant on Harrison Ave. Estimated cost $240,000. J. H. Ritchie & Associates, 250 Stuart St., Boston, are engineers.

Mass., Lynn—H. C. Batchelder, 170 Lynn St., Peabody, awarded contract for construction of a 1 story, 50 x 192 ft. artificial ice plant on Allerton St., to York Ice Machinery Co., 200 Causeway St., Boston. Estimated cost $40,000.

Mich., East Lansing — State Administrative Board, Lansing, will receive bids until February 11 for construction of a 2 story administration building, dining hall and boiler house addition here. Estimated cost $150,000. George P. Page Co., 407 Mutual Bldg., Lansing, is architect.

Minn., Bemidji—City will receive bids until February 15 for development of underground water supply, one million gal. daily capacity complete with pumps. Former bids rejected.

Minn., Sleepy Eye—City Council, will soon receive bids for remodeling and improvements to municipal power plant. A. J. Thomas, city clerk.

Mo., Chillicothe — Consumers Public Service Co., Percy Markham, Pres., Brookfield, will build a 100 x 125 ft. ice and cold storage plant here by local labor. Estimated cost $55,000.

Mo., Kansas City — Kansas City Power & Light Co., 14th St. and Baltimore Ave., will build a 1 story, 72 x 180 ft. power sub-station at 3410 Nicholson Ave. Estimated cost $40,000. Work will be done by owner's forces.

N. Y., Hawthorne—Hawthorne Water District, Hawthorne Public School, will receive bids until February 19 for waterworks improvements, including reservoir, pump house, mains, etc. Estimated cost $25,000. C. H. Sells, Inc., 15 Washington Ave., are engineers.

Pennsylvania—John L. Hanna, Secy. State Department of Property & Supplies, Harrisburg, will receive bids until February 24 for tunnel, electric power and lighting conduits, pipe conduits, switches, expansion joints, etc., at Clarion State Teachers College, Clarion and Polk State School, Polk, also tunnel extension, pipe conduit, expansion joints, etc., at State Teachers College, Mansfield. Estimated total cost $140,000. J. N. Chester, Clark Bldg., Pittsburgh, is engineer.

Utah, Washington—Dixie Products, Inc., St. George, having plans prepared for construction of cold storage, ice and poultry dressing plant here. Estimated cost $40,000. Architect not selected.

Va., Yorktown—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until February 24 for magazine and other buildings and structures, conveyor housings, conveyors, etc., at Naval Mine Depot here.

Wis., Superior — Superior Shipbuilding Co., Second St. and Lamborne Ave., plans remodeling power plant and installing two new boilers, also other plant improvements. Estimated cost $30,000.

B. C., Vancouver — Vancouver Harbor Commission, Dunbury Ave., plans construction of a cool room for storage of 100,000 boxes of apples including cooling equipment and mechanical devices for handling boxes of apples from cars to cool room and from cool room to ships' holds. Estimated cost $50,000. H. W. Frith, c/o Harbor Commission, is engineer.

Man., Gladstone—Manitoba Power Commission, Parliament Buildings, Winnipeg, plans an election on February 5 to vote whether they will buy electric power from Provincial hydro. If approved a transmission line will be built and electrical apparatus required.

Equipment Wanted

Motors—Vicksburg, Miss.—U. S. Engineer Office, P. O. Box 667, will receive bids until February 12 for seven, 220 v. a.c. 3 wire, 3 ph., 60 cycle electric motors for U. S. Engineer shops.

Pump—Greenville, Miss.—City Council, will receive bids until February 16 for installation of 1,750 g.p.m. electric driven turbine pump for lifting water from well into reservoir in connection with waterworks.

Power Equipment—Wahpeton, N. D.—Otter Tail Power Co., Fergus Falls, Minn., G. W. Welch, Ch. Engr., plans the installation of new power plant equipment including 7,500 kw. steam turbine.

Industrial Projects

Ariz., Venesia—Westener Gold-Lead Mines Co., E. L. Tomlinson, Pres. and Mgr., plans construction of a 1,000 ton flotation mill including installation of a 350 hp. Diesel engine and four air compressor plants.

Calif., Los Angeles—Chrysler Corp., Walter P. Chrysler, 341 Massachusetts Ave., Detroit, Mich., awarded contract for construction of a 1 story, 300 x 850 ft. automobile assembly plant and 2 story, 60 x 100 ft. administration building at Eastland and Slauson Aves., to William P. Neil Co. Inc., 4814 Loma Vista Ave., Los Angeles. Estimated cost $2,000,000.

Ind., Hammond—Lever Bros., 164 Broadway, Boston, Mass., awarded contract for plant additions, glycerine refining units, power plant additions and equipment at 1271 Indianapolis Blvd. here, to Stone & Webster Engineering Co., 49 Federal St., Boston, Mass. Estimated cost $100,000.

La., Harvey—Favrot & Livaudais, Hibernia Bldg., New Orleans, Archts., will receive bids until February 16 for construction of a 3 story can manufacturing plant here for Continental Can Co., 1 Pershing Sq., New York, N. Y. Estimated cost $125,000.

Me., Kennebunk—Kessler Shoe Co., awarded contract for a 4 story addition to factory to R. J. Grant, Kennebunk. Estimated cost $40,000.

Md., Baltimore—Continental Oil Co., Fairfield, awarded contract for construction of a Stratford treating plant for gasoline, 4,000 bbl. daily capacity here to Alco Products Co., 220 East 42nd St.

Mo., St. Louis—Kinloch Brass Casting Co., 2356 Palm St., awarded contract for construction of a 1 story, 59 x 70 ft. at 2110 Howard St. to C. L. Williams Realty Co., 518 South Vandeventer.

N. J., Bloomfield—General Electric Co., M. Chapman, in charge, 5 Laurence St., having revised preliminary plans prepared for a 1 story addition to factory. Estimated cost $40,000. Private plans.

N. J., East Rutherford—Flintkote Co., Maple St., awarded contract for construction of a 2 story plant to Ferber Construction Co., 16 Johnson St., Hackensack. Estimated cost $40,000.

N. Y., New York—Payson Varnish Co., 141st St. and Southern Blvd., plans construction of a 1 story, 45 x 95 ft. plant. Estimated cost $40,000. A. Pirner, 2742 East Tremont Ave., is architect.

Tex., Harrisburg—Shell Petroleum Corp., City National Bank Bldg., San Antonio, plans construction of additional unit to refinery including stills and a complete cracking unit near here. Estimated cost $250,000. Private plans. Contracts will be let soon for part of work, other work done by day labor.

Tex., La Porte—La Porte Oil & Refining Co., Inc., c/o J. D. Wrather, et al., La Porte and Gurley Oil Co., site under option and plans erection of an oil refinery, 2,500 bbl. daily capacity. Estimated cost $100,000. Private plans. Plan to let contracts and start construction some time in February.

Wash., Seattle—Aircraft Plywood Co., 1319 West Nickerson St., plans a 60 x 240 ft. addition to plant.

Wis., Madison—Oscar Mayer & Co., awarded general contract for a 1 story, 56 x 90 ft. addition to packing plant including electric refrigeration system, etc., to C. B. Fritz Co., 138 North Frances Ave. Estimated cost $40,000.